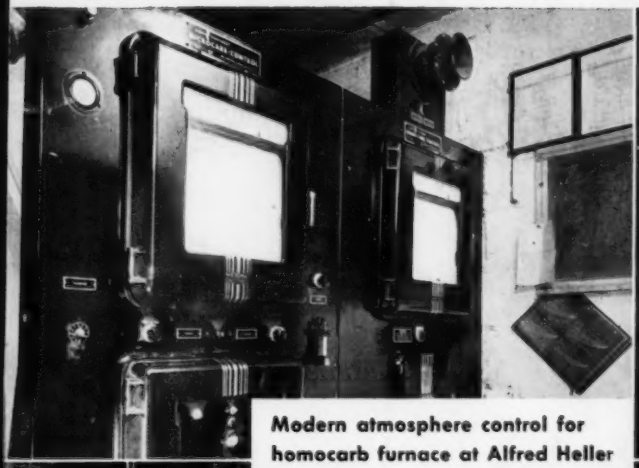
July-August 1955

METAL TREATING

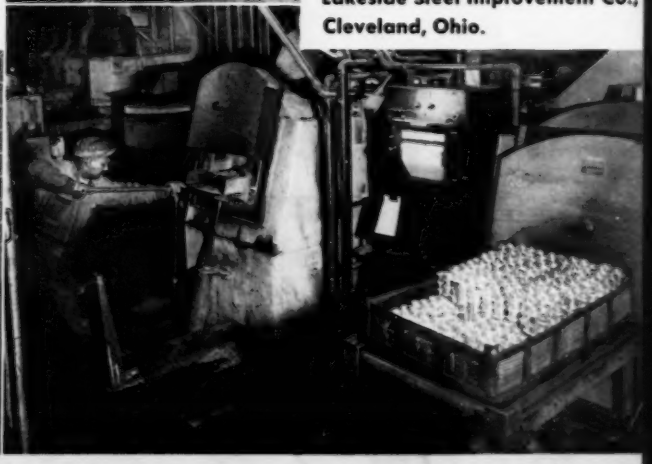
MASTER CRAFTSMEN
METAL TREATING INSTITUTE

These pictures illustrate the growing importance and emphasis placed upon control instruments in heat treating.



Modern atmosphere control for homocarb furnace at Alfred Heller Heat Treating Co., New York.

Furnace controls at the Lakeside Steel Improvement Co., Cleveland, Ohio.



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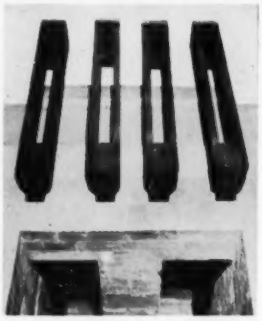
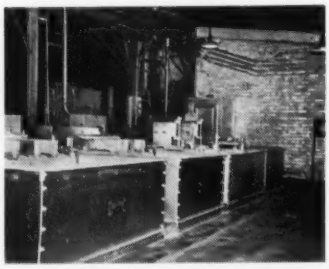


Type 701-4 Submerged Electrode Unit with ceramic pot for neutral hardening and annealing 1000-2300°F.



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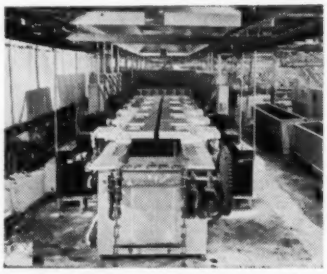

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Indexed in Engineering Index

EDITORIAL

More About the Importance of the Heat Treater

The following letter written to the Department of Labor presents what we think is the heat treating industry's viewpoints on a very important subject.

Mr. Rocco C. Siciliano
Assistant Secretary of Labor
U. S. Department of Labor
Washington, D. C.

Dear Mr. Siciliano:

I have delayed replying to your letter of May 16th in order to get a reaction from the membership of the Metal Treating Institute in connection with your committee's peculiar decision concerning the occupation of heat treater.

The membership of the Metal Treating Institute, as well as the management of basic industries operating heat treating departments, are unanimous in their feeling that there is no logic in this decision, and this opinion is not based on personal problems or opinions but upon the logic of comparison of other occupations which are currently classified as critical.

To anyone thoroughly familiar with all the aspects of the metalworking industry, there is no intelligent reason for omitting "Heat Treater, all around" from a critical list which includes as critical such occupations as tool and die maker; jig and template maker; instrument repair man; die setter; electronic technician; and engineer professional (all branches). In each instance the basic and critical work of the individuals involved in such occupations is inevitably associated in some way with heat treating functions and operations.

As pointed out in my recent editorial in the May-June issue of METAL TREATING of the ten *essential* activities listed by the Department of Commerce, it is an undeniable fact that seven of

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TITANIUM ALLOYS ARE HEAT TREATABLE

By **C. R. COOK,** *Senior Metallurgist*
Technical Department
Titanium Metals Corporation of America
Henderson, Nevada

Most titanium mill products supplied to date have been used in an annealed condition. In this relatively soft state, a considerable advantage over other materials has been realized in many applications. However, recent studies have shown that even greater advantages are offered through the application of more complex heat treatments to the titanium alloys.

Three General Types

There are three general types of titanium alloys available commercially. Outside of the commercially pure grades, only one alloy containing 5% aluminum–2.5 tin is available as a single-phase (alpha) alloy. The remaining alloys are two-phase (alpha + beta) and may be classified in two groups: (1) alloys containing 4 to 8% of beta stabilizing elements such as iron, chromium, molybdenum, manganese and vanadium; and (2) alloys containing lower percentages of these elements plus 1 to 6% aluminum.

The commercially pure alpha grades principally rely upon oxygen content to provide strength levels from 40,000 to 80,000 psi minimum yield strength. These grades are not heat treatable and are generally supplied and used in a 1300°F annealed condition which permits stabilization and stress relief through recrystallizing of cold worked metal. Commercially pure titanium is provided in any of the standard forms; however, most of the product is supplied as sheet and strip.

Because the 6% aluminum-4% vanadium composition is becoming very popular due to its unique combination of properties, it is used here to illustrate the heat treatability of titanium alloys. The alloy consists of both the alpha and beta phases at lower temperatures with the amount of alpha gradually decreasing upon heating until it becomes completely beta at about 1825°F (the transus temperature). With increasing temperature in the alpha – beta field,

Table I
Recommended Annealing Treatments and Typical Annealed Properties for TMCA Alloys

Grade	Composition	Approx. Beta Transus Temp.	Recommended Annealing Treatment
55A	Unalloyed	1675°F	1300°F
75A	Unalloyed	1800°F	1300°F
100A	Unalloyed	1850°F	1300°F
140A	2Fe-2Cr-2Mo	1550°F	1200°F (24 hrs.) AC
150A	1.5Fe-2.7Cr-0.25$_2$	1650°F	1200°F (24 hrs.) AC
155A	1.5Fe-1.4Cr-1.2Mo-5Al	1800°F	1200°F (24 hrs.) AC
Ti-6Al-4V	6Al-4V	1825°F	1300°F (2 hrs.) AC

Grade	Product	Tensile Strength psi	Yield Strength (.2%) psi	Elong. %	R.A. %
55A	Sheet	75,000	55,000	25	
	Bar	70,000	50,000	26	45
75A	Sheet	95,000	80,000	22	
	Bar	90,000	75,000	24	45
100A	Sheet	110,000	95,000	22	
	Bar	100,000	85,000	24	45
140A	Bar	138,000	130,000	26	45
150A	Bar	148,000	140,000	20	40
155A	Bar	160,000	145,000	15	35
Ti-6Al-4V		138,000	130,000	15	40

the beta phase becomes leaner in vanadium content and consequently less stable. As the temperature approaches and exceeds the beta transus, the grain size becomes quite coarse. As for most titanium alloys, heating to temperatures at or above the beta transus should be avoided unless heavy reductions in area (of more than 20%) by forging or rolling are subsequently applied. Once overheated, if not thoroughly worked, a loss in ductility may occur and cannot be fully recovered by subsequent heat treatment.

Annealing Treatments

Simple annealing treatments for this type of alloy are carried out at intermediate temperatures in the alpha – beta field (1000-1400°F) where mixtures of alpha and stable beta phases are brought to equilibrium. One such annealing treatment, for example, calls for two hours at 1300°F followed by air cooling which produces, in a well-worked material, an alpha – beta structure having nominally the following properties:

130,000 psi	Yield Strength, 0.2%
140,000 psi	Tensile Strength
17%	Elongation
50%	Reduction of Area

A typical microstructure of the alloy in this condition is shown in Fig. 1.

The simple annealing treatment has been used for most titanium alloys to date because it provides a rather easily controlled process which results in maximum structural stability and a good combination of properties in both heavy and light sections. The recommended annealing practices and typical properties for all TMCA commercial grades are shown in Table I.

Much higher strengths can be obtained with the

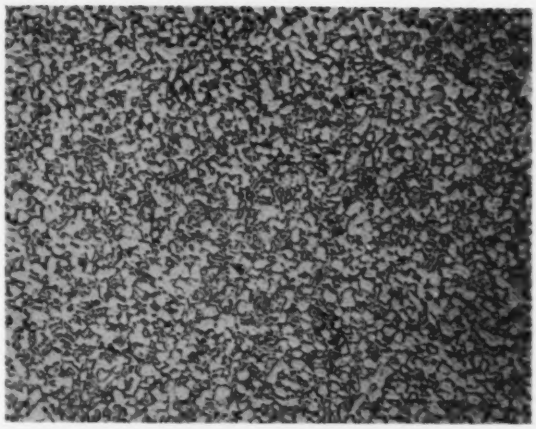

Fig. 1—Ti-6A1-4V Alloy—1300°F (2 hours) A. C. Alpha-beta structure of annealed material (500X).

Ti-6A1-4V alloy by a duplex type heat treatment consisting of a solution treatment high in the alpha – beta field, rapidly cooling and subsequently aging at lower temperatures. The solution treatment produces a relatively unstable beta phase which on aging decomposes to a fine alpha precipitate in a matrix of enriched stable beta phase. For example, the Ti-6A1-4V alloy can be solution treated in the range of 1500° to 1750°F, water quenched and aged at temperatures from 900° to 1200°F. For this alloy, the optimum solution treatment (that most susceptible to subsequent age hardening) is the 1550°F water quench. This treatment produces the lowest yield/tensile ratio, the lowest hardness and maximum ductility (See Table II).

The aging treatment provides a more stable condi-

Table II

Typical Mechanical Properties of Ti-6A1-4V Alloy-Forged Bar

Heat Treatment	Tensile Strength psi	Yield Strength (.2%) psi	Elong. %	R.A. %	Y.S./T.S. Ratio
1200°F (2 hrs.) AC	139,400	130,100	15.0	42.6	0.93
1200°F (24 hrs.) AC	137,600	130,800	14.6	42.2	0.95
1400°F (2 hrs.) AC	136,900	127,000	17.0	48.4	0.93
1550°F WQ	145,000	103,000	26.0	55.0	0.71
1550°F WQ + 900°F (24 hrs.) AC	165,000	155,000	14.5	46.5	0.94
1000°F (24 hrs.) AC	149,000	147,000	20.0	52.0	0.98
1750°F WQ	172,000	148,000	16.0	53.0	0.86
1750°F WQ + 900°F (24 hrs.) AC	176,000	162,000	16.0	52.0	0.92
1000°F (24 hrs.) AC	168,000	156,000	16.0	59.0	0.93

Table III

Effect of Quenching Rate on Mechanical Properties of Ti-6A1-4V

Heat Treatment	Tensile Strength psi	Yield Strength (.2%) psi	Elong. %	R.A. %
1750°F (1 hr.) NaOH (Q) + 1100°F (2 hrs.) AC	160,100	150,400	14.4	48.4
1750°F (1 hr.) AC + 1100°F (2 hrs.) AC	139,700	125,000	15.5	43.6

Table IV

Effect of Section Size on Mechanical Properties Obtained by Duplex Heat Treatment of Ti-6A1-4V Alloy

	Tensile Strength psi	Yield Strength (.2%) psi	Elong. %	R.A. %
1750°F (1 hr.) NaOH (Q) + 1100°F (2 hrs.) AC 4½" Round x 6"				
Outside, Long.	144,800	129,800	17.5	45.0
Center, Long.	136,200	123,000	15.2	33.3
Trans.	138,000	124,200	12.5	33.9
Average	139,700	125,700	15.1	37.4
1750°F (1 hr.) WQ + 1100°F (2 hrs.) AC				
Center 3" Round x 6" Long.	137,000	130,000	15.0	28.0
Center 2" Round x 6" Long.	143,000	141,600	13.0	24.0
Center 1" Square x 6" Long.	150,000	145,000	16.0	32.0
Center ½" Round x 6" Long.	159,000	150,500	13.0	25.0

tion for elevated temperature applications as well as much higher strength levels. Although excellent properties can be obtained on aging from the 1550°F solution treated condition, somewhat higher strengths at good ductilities are obtained on aging from the 1750°F water-quenched condition. Typical structures obtained on solution treatment and on subsequent aging are shown in Figs. 2 and 3.

The selection of the optimum solution temperature is somewhat critical if the lowest yield strength is to be obtained, since the use of a 50°F higher or lower temperature will result in 10,000 to 15,000 psi higher yield strengths. Quenching from the optimum solution temperature has the following advantages as it provides for:

(1) Optimum formability (lowest yield-tensile ratio).

(2) Optimum machinability (lowest hardness).

(3) Maximum depth of hardening on subsequent aging.

Selection of the aging temperature is not as critical, although a wide range of properties is obtained by the application of various temperatures and times. A few typical properties obtained in one-half inch forged flat bars, after several treatments, are shown in Table II.

The section size applicable to a duplex treatment is limited due to the relatively low thermal conductivity of titanium. The cooling rate in the center of heavy sections is not sufficiently fast to completely retain the beta phase; some decomposition of beta occurs on slow cooling, which makes it impossible to achieve high strength levels on subsequent aging.

The effect of cooling rate from the solution temperature is demonstrated by the data in Table III while the effect of section size is shown in Table IV. The NaOH quench, which represents a cooling rate faster than that obtained by water quenching, permits aging to a 160,000 psi tensile strength; whereas air cooling from the solution temperature, followed by

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Fig. 2—Ti-6A1-4V Alloy—1550°F (1 hour) W. Q. Alpha-beta structure of solution treated alloy (500X).

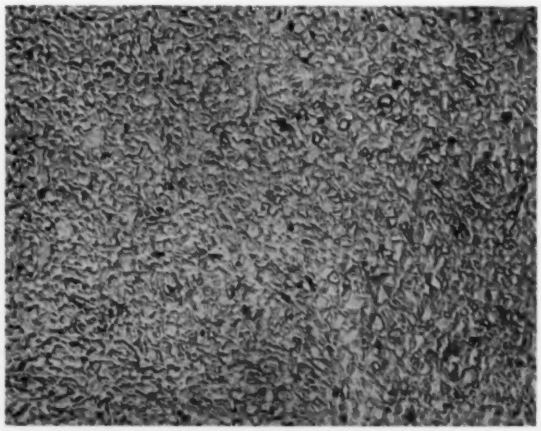

Fig. 3—Ti-6A1-4V Alloy—1550°F (1 hour) W. Q. +900°F (24 hours) A. C. Structure of solution treated and aged material (500X).

Tool Steel Topics

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation

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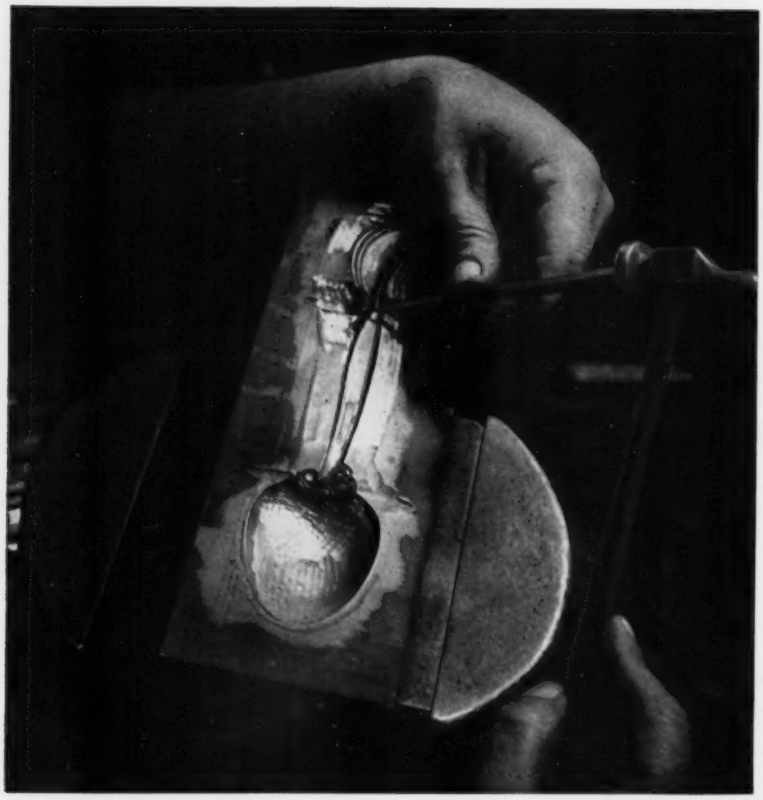

Maker of Tableware Likes Economy of Striking Die of Bearcat

A maker of stainless steel tableware had been using striking dies which produced average runs of 19,000 pieces. Good, they thought, but perhaps by experimenting they could find something better. So they decided to switch to Bethlehem Bearcat Tool Steel, then watch their production figures. The number of pieces per die doubled, right from the start.

The Bearcat dies, used in working grade-rolled stainless blanks of varying thickness, are hardened to Rockwell C 56-58. As no redressing is possible, they are run until failure occurs. The shop superintendent says: "Bearcat is doing a phenomenal job. We particularly like its resistance to shock."

Besides shock-resistance, Bearcat is well suited for any application where good machining is essential. It is deep-hardening in air, and offers low distortion in heat-treatment. For some applications, it can be carburized easily for long wear.

TYPICAL ANALYSIS

C	Mn	Si	Cr	Mo
0.50	0.70	0.25	3.25	1.40

In addition to its use for striking dies, Bearcat is also ideal for master hobs and engraving dies, used in related industries. You're sure to like Bearcat, no matter where you try it. Why not order a supply today from your local tool steel distributor, or from our well-stocked mill depot.

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BETHLEHEM TOOL STEEL ENGINEER SAYS:

You Can Reduce Warpage by Supporting Tools During Heat-Treatment

Warpage of tools in heat-treatment is usually associated with the geometrical shape of the tools, or the manner in which they are supported during heating for the quench. When steels are heated in the critical range, just prior to quenching, they are weak, and if not supported properly, will sag or flow plastically.

Long tools should be supported at frequent intervals along their length. If section changes are present for appreciable lengths, the tools should be supported at each section. However, the span between supports should not exceed three times the tool diameter.

LEHIGH S SLITTER KNIVES MAKE SHORT WORK OF STRIP STEEL

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Table V
Examples of Solid Solution and Aging Treatments for Ti-155A

Heat Treatment	Tensile Strength psi	Yield Strength (.2%) psi	Elong. %	R.A. %	Y.S./T.S. Ratio
1575°F (1 hr.) WQ	159,000	150,000	16.0	32.0	0.94
1575°F (1 hr.) WQ-1100°F (8 hrs.) AC	171,000	166,000	14.0	37.0	0.97
1675°F (1 hr.) WQ	187,000	102,000	14.0	16.0	0.55
1675°F (1 hr.) WQ-1000°F (2 hrs.) AC	222,000	195,000	4.0	3.0	0.88
1675°F (1 hr.) WQ-1100°F (24 hrs.) AC	172,000	168,000	14.0	42.0	0.98
1200°F (24 hrs.) AC (Std. Anneal)	153,000	150,000	18.0	39.0	0.98

Table VI
Example of Special Heat Treatments for Ti-140A

Heat Treatment	Tensile Strength psi	Yield Strength (.2%) psi	Elong. %	R.A. %	Y.S./T.S. Ratio
1300°F (1 hr.) WQ	147,500	144,500	12.0	16.0	0.98
1300°F (1 hr.) AC	145,500	143,500	25.0	42.0	0.99
1300°F (1 hr.) AC- 900°F (48 hr.) AC	159,500	151,000	18.0	42.0	0.95
1500°F (1 hr.) WQ	190,000	178,500	3.0	4.0	0.94
1500°F (1 hr.) WQ-1000°F (2 hrs.) AC	187,500	183,000	10.0	35.0	0.98
1600°F (1 hr.) WQ	Extremely brittle; not possible to obtain good test				
1600°F (1 hr.) WQ-1200°F (2 hrs.) AC	162,000	158,000	18.0	40.0	0.98
1200°F (24 hr.) AC (Std. Anneal)	138,500	137,500	25.0	48.0	0.99

the same aging treatment, produced some 20,000 psi lower strength with about the same ductility. It can be seen in Table IV that the center of a four and one-half inch round will not respond as desired to such a treatment; and progressively higher strengths are obtained as the size of the quenched section is reduced.

Duplex treatments similar to those described for the Ti-6A1-4V alloy can be successfully applied to other alpha – beta alloys containing both aluminum and beta stabilizing elements. Similar treatments also can be used for non-aluminum containing alpha – beta alloys, although the low yield strengths and the distinct minimum yield/tensile ratio are not obtained.

The properties which can be developed in Ti-155A by heat treatment are given in Table V. The results show that tensile strength levels from approximately

(Continued on page 33)

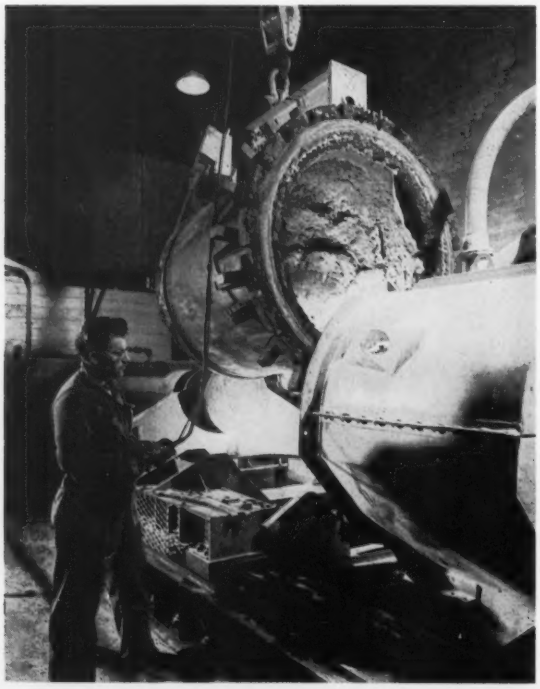
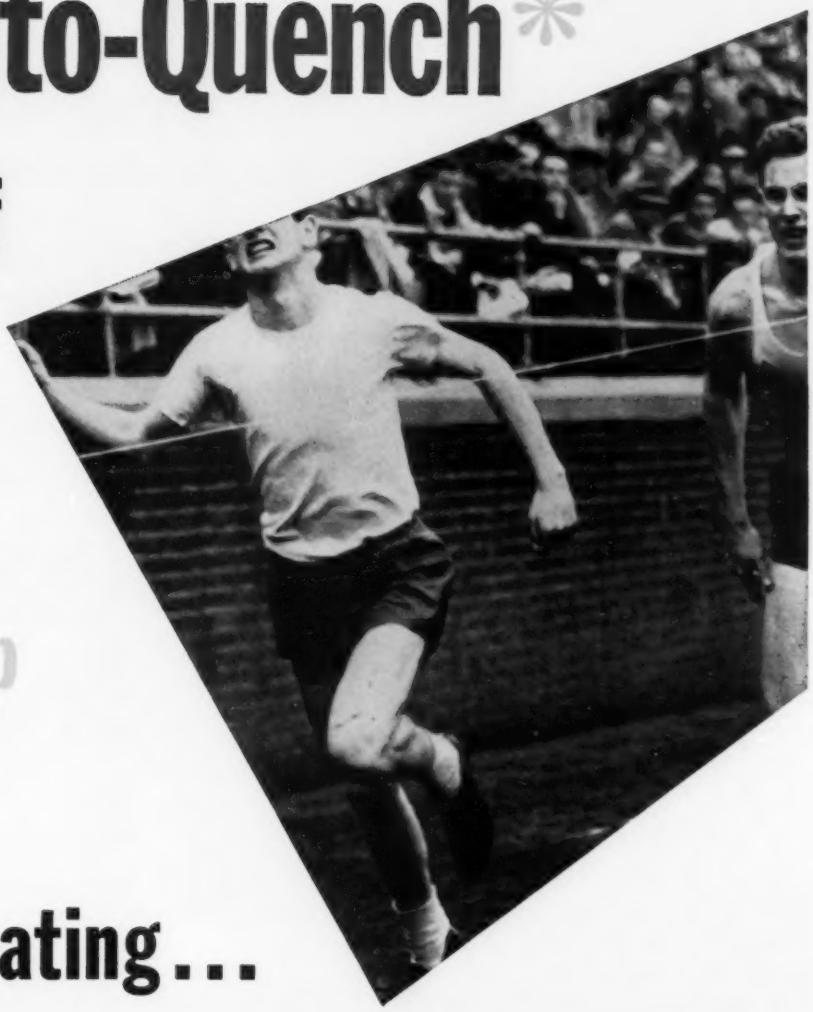


Fig. 4—Lowering Krolly reactor shell containing titanium sponge into a boring mill. The metallic titanium sponge chips will be further purified by acid leaching, then melted in a 400 lb. ingot.

Fig. 5—Vacuum fusion analysis equipment at the Technical Department, Henderson, Nevada. Control of oxygen, nitrogen and hydrogen are of utmost importance in the manufacture and fabrication of titanium.

Houghto-Quench*

pays off on that crucial last step in heat treating...



The tape's not broken until the *last step* is taken. And in heat treating a lot depends on the crucial quench.

After you've made sure of your steel analysis, temperature, and atmosphere, it's the *quench* that pays off if it's *right for the job.*

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A Review of

SALT BATH CARBURIZING

Part II

By **E. N. CASE,** *Supervisor*
Metal Chemicals Section,
American Cyanamid Company
New York, N. Y.

Editor's Note: *This is the concluding installment of the article, Part I of which appeared in the May-June issue.*

As discussed in the preceding installment, the commercial carburizing baths available today are dependent upon a cyanide as the active agent. Such baths have the usual advantages of molten salt baths and can be provided to operate over a wide range of temperatures. Although many molten salt baths are relatively small in size, since a small salt bath can be operated economically, it is also true that many large mechanized salt units have been installed with which it is possible to carry out a complete heat treating cycle without the handling of the parts except to rack them at one end and remove them at the other. As an example, the production of .040" case on refrigerator crankshafts in one plant involves carburizing at 1725°F., air-cooling, reheating to 1525° to 1550°F., in an all-chloride bath, quenching into an austempering bath at 600°F. and air-cooling. The parts are then washed and delivered at the exit end of the machine, clean, dry and ready for use, with no manual handling.

In the development of molten carburizing baths, the early work was done with sodium cyanide or with sodium cyanide with mixtures of simple chlorides and carbonates. Baths of this type are still in use today, primarily for the production of very light cases, and the treatment is designated usually by the term "cyaniding". The case produced is relatively high in nitrogen and low in carbon as compared to more recently developed baths. Cyaniding is a simple operation, and provided a minimum cyanide content of 20% or so is maintained in the bath, reliable results may be expected. Since adequate access to air is necessary, the bath must be run without a carbon cover so heat losses and cyanide losses are substantial. The case for all practical purposes is limited to .010" since beyond this depth very high cyanides and very long times are required.

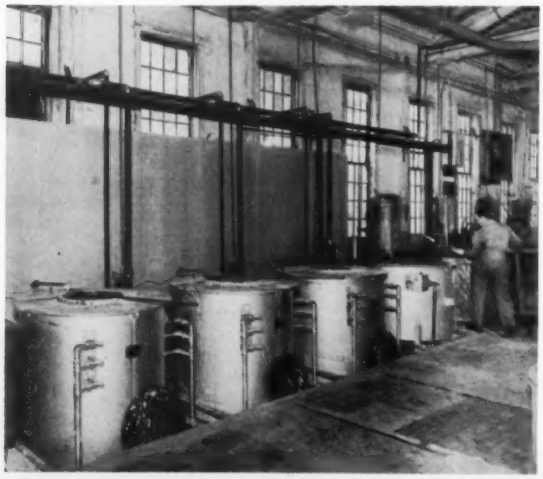

Fig. 1—A line of Dempsey pot-type furnaces for salt bath carburizing.

Various Catalysts

In the 1920's and 1930's compounds of the alkaline earths—calcium, barium and strontium—were discovered as catalysts and employed in carburizing baths.

The calcium based bath necessarily involved the use of calcium chloride in the melt. Calcium chloride is hygroscopic; that is, it tends to pick up moisture and parts so treated would be very likely to rust if not carefully cleaned. Vapors from the bath also contain calcium chloride and cannot be allowed in a precision machine shop.

The use of barium instead of calcium involved considerable changes in the technological operation of the bath. This appears strange because the elements are chemically similar, but the operating differences were marked. The operating cyanide level of a *calcium* base bath can be as low as ¼ of 1% sodium cyanide equivalent. A barium base bath does not permit the same type of calcining which occurs with a calcium product, and therefore, it was necessary to operate at much higher cyanide levels. The barium base bath in most common use today is held between 16 and 24% sodium cyanide equivalent and can be operated up to about 1650°F. with very uniform and reliable results. The carburizing rates are very closely equivalent to those obtainable by means of a calcium base bath, and

operation of such a bath, properly formulated, is quite simple. Baths based on barium were widely used beginning about 1933 or 1934.

A further extension of the barium base bath was a high temperature variation which had some unusual characteristics. Operation at higher temperatures permits the use of lower cyanide concentrations, and results in lower cyanide losses during operation. The concentration of the catalyst was increased in order to activate the bath properly, and under such conditions, a bath was obtained which would operate at 1700 or 1750°F. to produce rapid case penetration combined with the rapid heating characteristic of any salt bath operation. Baths of this type were in use during the second World War for the carburizing of armour plate and are still used throughout industry for the production of deep cases on such things as ball bearing races and crankshafts for compressors.

This high temperature barium base bath, while it provided extremely rapid case penetration, could not be operated below about 1675°F. without a loss in penetration rates as compared with other baths such as those discussed earlier. Also, due to its higher barium content, it was relatively difficult to wash from the work although it was not hygroscopic as was the case with the calcium materials.

Strontium compounds are similar to barium in their reactions and were never widely used because of their high cost.

Baths containing calcium, barium, or strontium compounds, while effective and reliable from the carburizing standpoint, are difficult to clean from oil-quenched work particularly if the parts contain blind holes, internal threads, or sharply undercut areas. Much time and effort was spent on the development of water soluble carburizing baths, and in the last few years several were developed which were considerably

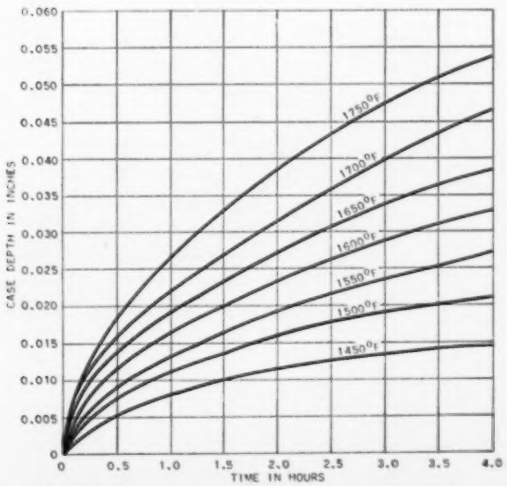

Fig. 2—AEROCARB® time—penetration study of S and R carburizing compounds showing depth of case as measured on fractured S. A. E. 1020 test pieces, brine quenched.

Fig. 3—A line of Holden furnaces for salt bath carburizing.

improved over previous products. One was finally developed which gave case depths equivalent to those obtained with barium catalyzed baths and which could be washed from the work about as readily as plain sodium cyanide.

It soon became apparent that there would be many advantages in extending the operating range of a water soluble catalyzed bath, particularly one which gave such unusually good case depths. A program toward this end resulted in a bath which was announced at the ASM Metals Show. It was designated as AEROCARB® S and R carburizing compound, and can be operated at temperatures from 1600 to 1750°F, although operation at temperatures below 1600°F. is possible under most conditions. Typical carburizing curves are shown in Figure 2, and it will be noted that the penetration rates are unusually high. Case characteristics are similar to those of barium base baths, and unlike most other water soluble carburizing baths available today, the carbon content of the case increases as the temperature goes up. The nitrogen content of the case increases with temperature in most of the baths which have hitherto been available. With the new bath, however, this trend is reversed and higher carbon cases that are lower in nitrogen can be obtained at 1700°F and 1750°F.

Operating range is 10 to 14% cyanide, and work quenched in oil directly from this bath is readily washed free from adhering oil and salt.

In the operation of any carburizing bath at high temperatures, particularly at 1700 or 1750°F., the maintenance of an adequate carbon cover is essential. At these high temperatures, cyanide breakdown is much more rapid than it is at lower levels so that operation of a bath in this range without a carbon

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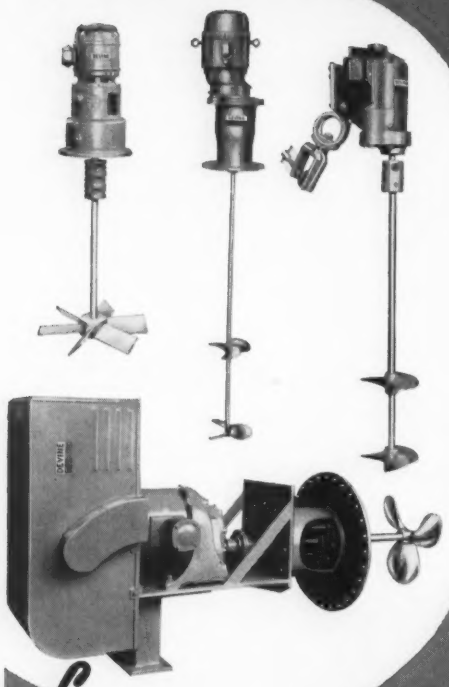

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cover results in very rapid loss of cyanide. At the same time, the carbon cover minimizes heat loss and eliminates fuming so that there are many advantages in the maintaining of such a carbon cover.

Advantages of Salt Bath Carburizing

Salt bath operation for carburizing purposes has a number of practical advantages that are best pointed out by means of examples.

In carburizing the blades of scissors, for example, it is desirable to obtain an adequate case on the blades themselves but to have this case only below the point at which the blades are pivoted. This is done merely by immersing them in the bath from simple rod fixtures so that they extend into the bath to a point only slightly above the shoulder of the blade. On quenching out, they are then carburized in the required area and hardened only within this range. No stop-off material is required.

Another good example of the versatility of salt baths is illustrated by the idler pulley bearing which is made by the Bearings Company of America. Case depths are specified from .010 to .060 of an inch, depending upon the bearing which is involved. The idler pulley bearing requires two different case depths, one of .030 and one of .010, while a thrust bearing race, which is manufactured for automotive applications, requires .060 case to support the loads which are placed upon it in practice. All of these are carburized in the same carburizing bath, a barium base deep casing bath operating at 1700 to 1725°F. Generally, the parts are stabilized at 1450°F. in a neutral type salt and then water quenched before tempering in a tempering salt. The reduction of distortion reduced the amount of grinding which had hitherto been required and reduced the rejects from initial levels of 10 or 12% to well below 2% on production. In addition, the rejects can in many cases be salvaged, whereas before this was not possible.

An interesting application of a carburizing bath in an unusual process is one involving key case hooks which were made by S&Z Hooks Company of Brooklyn. In order to obtain the soft forming characteristics which were necessary to permit forming and heading of the hooks, it was desirable to use a low carbon steel. The use of spring steel, in addition to making the forming much more difficult, would have involved excessive wear on the forming dies and much higher pressures in the forming press. It was hoped that it might be possible to carburize these hooks after forming to obtain the properties of a spring steel. This was done in salt after considerable study and experimentation and with through carburizing making possible the inexpensive formation of these key case hooks.

Two more examples are a rocker arm for a refrigerator temperature control unit and a swivel pin for an oscillating fan. The first of these is made of a 1010 carbon steel and is carburized to .005 meeting a minimum specification of 80 Rockwell 15-N. In a complex

(Continued on page 33)

Why another plant converted to "HOT RODS" 100%

J. Bishop & Company Platinum Works reports CRYSTOLON* heating elements outlast others by 3-to-1 in Drever furnaces

CRYSTOLON Heating Elements, or "Hot Rods", are a typical Norton Rx — an expertly engineered refractory prescription for greater efficiency and economy in electric furnace and kiln operation. Made of self-bonded silicon carbide, each rod has a central hot zone and cold ends. Aluminum-sprayed tips and metal-impregnated ends minimize resistance and power loss. Available in standard sizes and interchangeable with your present rods.

One of the Three Drever Electric Furnaces at the Frazer, Pa., tube mill of J. Bishop & Company Platinum Works, specialists in small diameter stainless steel tubing (.008" to 1" O.D.), tubular fabricated parts, surgical instruments and refiners of precious metals.

Wherever it uses silicon carbide heating elements — as in its Drever electric furnaces — J. Bishop & Company has changed over completely to "Hot Rods."

The reason: other elements lasted only 6 months — ***"Hot Rods" averaged 18 months' service life!***

More and more, this 3-to-1 longer life of Norton CRYSTOLON elements is becoming recognized for the truly sensational performance that it is — and a constantly growing number of economy-minded electric furnace operators are taking advantage of it.

But there's a good deal more to this benefit-story. The longer life of "Hot Rods" means you save on element costs — because you use less of them. Also, fewer changes of elements and voltage taps mean greatly reduced maintenance, and a much smoother production flow.

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on how "Hot Rods" can improve and economize your own electric furnace or kiln operations. Send for the big illustrated booklet, "Norton Heating Elements." NORTON COMPANY, Refractories Division, 626 New Bond Street, Worcester 6, Mass.

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An Unusual

COMMERCIAL HEAT TREATING PLANT

Effective control of heating, cooling and atmosphere provides excellent production versatility

Commercial heat treating operations require an unusual amount of versatility to satisfy customer demand; continuous production of one part over a period of time is the exception rather than the rule. However, some degree of specialization is necessary to limit, in some way, the many possible variations in size, type of material and treatments. At Bosworth Steel Treating Company, Detroit, Michigan, specialization means providing fast, competent service in treating ferrous parts in small sizes on a production basis. The sizes are naturally limited only by the tray sizes which are 12″ x 12″ x 20″; 12″ x 18″ x 30″; and 18″ x 20″ x 30″.

Controlled atmosphere treatments make up the majority of all work. These include gas carburizing, carbon restoration, clean hardening and gas cyaniding (carbonitriding). Annealing and stress relieving make up the balance.

Isothermal heat treatment is an important factor in operations at the plant since many parts are handled which require close control of distortion. A recently installed mechanized batch-type furnace with hot oil quench is now used for this work, and results on many shapes and sizes over a period of time have proved excellent. In a number of cases, test runs have been used to establish definite distortion limits which were subsequently allowed for in machining. This has resulted, at times, in the elimination of some finishing operations such as straightening or a second rough-machining after heat treatment or any final grinding operations.

Equipment

Since its incorporation five years ago, the plant has shown a continual growth and has operated on a twenty-four hours a day, seven days a week basis. This 'round-the-clock schedule has provided maximum production from each unit without excessive maintenance by eliminating the greatest cause of furnace failure—extreme temperature variation caused by temporary shut-down and refiring.

Equipment was selected to meet four main requirements: mechanization, practical control of heating, control of cooling, and controlled atmosphere. All of the units now in operation at the plant are used interchangeably for any of the controlled atmosphere processes, resulting in continuous operation of a minimum number of units.

One manufacturer's equipment which met the requirements above was selected for use throughout the plant to simplify operation and maintenance. Most of the units are installed in-line on one conveyor. This "mainline" is shown in Fig 1.

Equipment consists of the following Dow Furnace Company units:

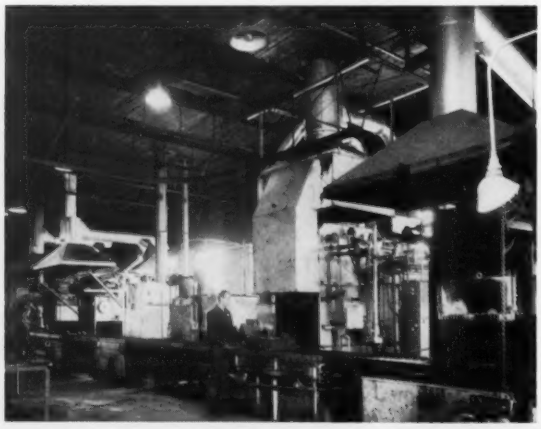

Fig. 1—Part of a battery of atmosphere units used for various heat treating operations.

Fig. 2—Furnace for isothermal treatments for the control of distortion. The quench has temperature, duplicating and variable velocity controls. Note the turntable for ease of loading.

One Model "J" with hot oil quench—1450°-1650°F. operation
Three Model "B" with normal oil quench—1450°-1650°F. operation
Three Box-type tempering furnaces—250°-1300°F. operation
One Washer

The model "J" provides complete hot oil quenching control for isothermal treatment (Fig. 2). The main features of this auxiliary equipment are radiant-tube heating and variable-speed drive on the circulating propeller for control of oil velocity through the work. Maximum velocity provides high quenching power. Low velocity quenching, however, is used where minimum distortion is demanded. The furnace itself provides a high degree of mechanization and work containers can be held in three positions—one in the heating chamber, one in the vestibule for cooling in atmosphere or ready for loading, and one in the quench.

The other three high-temperature furnaces in the plant have many of the features similar to the unit equipped for hot oil quenching. All utilize internal generators and are natural gas fired. Carbon potential is controlled by CO_2 measurements for high carbon and by dew point measurements for low carbon work. Controlled additions of natural gas or ammonia are made in the furnace as required for surface treatments. Carbon restoration work is a specialty for a wide range of products.

Before heat treatment, all work is thoroughly washed and dried to prevent contamination of furnace atmospheres, a most important factor in this type of work. As shown in Fig. 3, the washer is served by the same conveyor used to load the high temperature furnaces, thus reducing handling.

Tempering is done in three box-type, high-velocity, forced-convection furnaces; two are shown in Fig. 4.

(Continued on page 26)

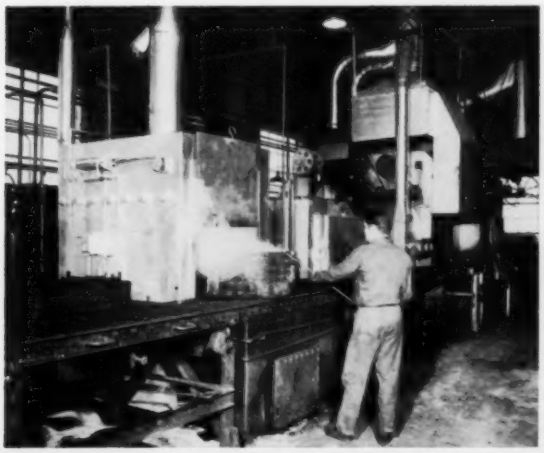

Fig. 3—Washing machine where all parts are thoroughly cleaned. The drier is to the right.

For precision cleaning of molds and dies—

NEW PANGBORN HYDRO-FINISH

gives you: Fewer moving parts
Easier handling—Added efficiency

Now Pangborn's famous Hydro-Finish is yours with added convenience and efficiency! Holding fine tolerances, Hydro-Finish cleans molds and dies in minutes . . . offers many new advantages. Pangborn has done away with the pump; air jet sluriators now keep the abrasive in suspension. This means a lower investment and fewer moving parts. Optional loading stand simplifies handling, washing and inhibitor application. The cabinet has been redesigned for more efficient operation. These and other advantages make the new Pangborn Hydro-Finish ideal for precision cleaning and finishing!

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Right Or Wrong In

LABOR RELATIONS

By **LAWRENCE STESSIN**

Editor's Note: *This department presents, in each issue, a round-up of day to day in-plant problems and how they were handled by management. Each incident is taken from a true-life grievance which went to arbitration. Sources of these cases will be given upon request.*

Does "seniority" give a worker a right to pick the best shift?

What Happened:

W. O. Garrett worked on the second shift. After three years he was given a raise and reclassified to a higher skill. It so happened that another employee by the name of J. C. Driver was doing the same work as the promoted Garrett, but he was on the first—and preferred—shift. But Garrett had more length of service. So he insisted that because of his promotion and higher seniority he should be transferred to the first shift. The company said that a man cannot exercise his seniority rights on shift preferences—seniority is applicable only in "promotions, demotions and layoffs." And besides, management has the inalienable right to schedule employees and assign work. But Garrett came back and charged that the company had always given senior men shift preferences, and that contract or no contract, a precedent had been set.

Was Garrett: RIGHT ☐ WRONG☐

What Arbitrator Alex E. Ralston, Jr. Ruled: "In interpreting the collective bargaining agreement, the arbitrator must look not only to the literal language, but also the modes of the action that have grown up around it over the course of time. In this case, for many years, it has been the practice of the company to accord senior employees in a classification, shift preference. This has not been treated as a right reserved by the company which it granted to some and denied to others at its discretion. The evidence discloses no prior instances when a senior employee was denied shift preference. It is therefore the view of this arbitrator that the grievance of W. O. Garrett must be sustained."

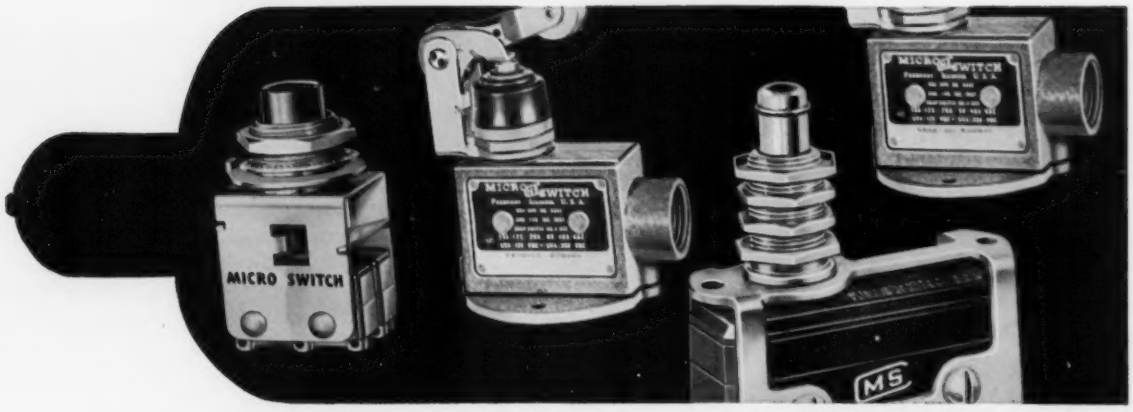
When can't you deny "holiday pay" to an employee?

What Happened:

In most companies a worker is paid for a holiday only if he works the day before and the day after. This particular company had such a rule in effect. It did, however, have this exception:—holiday pay will be given even if the employee doesn't show up the day before or after where absence is due to sickness, death in family, or "similar good cause." The day after July 4th, a national holiday, 17 men came to work as usual. They were greeted by their supervisor who told them that the department was shutting down because a wildcat strike in another part of the plant had created a shortage of materials. When payday came around, the 17 who had reported for work found no 4th-of-July pay in their envelopes. They

(Continued on page 31)

Armour Ammonia helps make MICRO SWITCH the leader in the precision switch field!



Carbonitriding with Armour ammonia holds the precision parts to watchmaker's tolerances – assures long life, high capacity and accurate repeatability

"In the manufacture of MICRO SWITCH snap-action switches the keynote is precision. Each and every part of the more than 8000 different switches must be held to extremely close tolerances in each step of its production. In our heat treating operations, Armour ammonia is used as the carbonitriding atmosphere and allows the clean, non-decarburizing hardening of switch parts. As a result, each part can be finished to final tolerance *before* heat treating with only a polishing operation necessary afterward.

"In addition, clean, non-decarburizing heat treating with Armour ammonia, done in our own plant, allows much shorter production schedules effecting a saving of both time and money in the fabricating process."

Lloyd Froning, Tool Room Supervisor
Micro Switch Division of
Minneapolis-Honeywell Regulator Co.

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When they specify Armour, manufacturers get more than ammonia. Armour has sponsored a fellowship at a leading technological university for the study of metal treating processes using ammonia. The results of this research are available to you. Furthermore, the men of the Armour Technical Service Department are equipped to handle and answer any problems arising with ammonia installations for metal treating. Write today for free copies of the booklets offered at right. If your problems are unusual or pressing, write, giving full details.

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METALS "CUSTOM-TAILORED" THROUGH CONTROLLED HEAT TREATING

By **JOHN J. KENNEDY,** *Industry Engineer*
Minneapolis-Honeywell Regulator Co.
Philadelphia, Pa.

Just as in a foreign city where "English spoken here" assures an American traveler of satisfaction with a purchase, so in metal processing, "Instrumentation used here" guarantees a purchaser of a "custom-engineered" metal product. The close control of temperature during heat treatment affected by instrumentation can modify the properties of treated materials to meet all specifications—any time.

In this article, some of the factors involved in the selection of instruments for heat treating operations will be considered, and some typical systems of instrumentation for accomplishing desired results will be described.

Temperature Considerations

The measurement and control of temperature during heat treating operations are basic considerations in any study of this phase of the metal treating industry. All heat treatment involves the application of heat followed by the cooling of a batch of metal, both operations being conducted under certain definite conditions—of time, temperature, and/or atmosphere—to achieve certain definite property changes in this batch of metal.

In order that these same property changes can be repeated in subsequent batches, the same conditions of heat treatment and cooling must be maintained.

Close regulation of temperature—its measurement and control—is, therefore, of vital importance to consistent production. Measurement must be accurate and reproducible; control must be reliable; the degree of these qualities depending on the particular job specifications.

Fig. 1—View of typical heat treating furnace. Brown ElectroniK Pneumatic Controllers, at right, control temperature of each furnace zone.

Thus, in aluminum heat treating, for example, the work is heated for varying periods of time at critical temperatures to achieve particular characteristics in the end product. In this case, very close and accurate temperature control must be maintained throughout the charge and during the length of the entire cycle to insure the proper physical properties.

In contrast to this operation, the simple hardening of a low carbon steel can be accomplished satisfactorily with an on-off controller which maintains the *average* temperature conditions constant.

Type Of Measurement And Control Determined By 'Specs'

For heat treating, measurement of the high temperatures involved in the various processes is accomplished by the thermo-electric method. This method, employing a thermocouple, connecting extension lead wire, and an indicating or recording pyrometer, provides a flexible and highly accurate means of accomplishing such measurement.

Pyrometers are available with a wide variety of control forms in both potentiometer and millivoltmeter types, and selection of them depends on application requirements as to accuracy, reproducibility, and so forth.

Two general types of pyrometers are in use including the highly accurate null-balance potentiometer and the simpler and less-expensive millivoltmeter. Each type, in turn, is available with any of a wide variety of control forms. These include

electric on-off or two-position control; electric proportioning control for both millivoltmeters and potentiometers; pneumatic on-off or two-position control; and pneumatic proportioning control for potentiometers only.

Heat Treatment Of Electrical Steels

Let us consider, briefly, the measurement and control of temperature in a specific operation—the heat treatment of electrical steels—to illustrate the basis of selection. Heat treatment of electrical steels—those to which certain alloying elements have been added to improve their electrical characteristics—must be carried out with exacting care because of the extremely close tolerances involved.

In a typical heat treating furnace used for this operation—a two-zone, semi-muffle, under-fired box type, as shown in Fig. 1—temperature control of each zone is accomplished with a Brown *ElectroniK* Circular Chart Recorder-Controller.

This instrument, a null-balance potentiometer, employs a pneumatic control element to throttle a diaphragm motor valve installed on the combustion air line to the gas burners. In accordance with the temperature requirements of the furnace zone, as measured by a thermocouple, the controller positions the valve to supply the proper amount of combustion air to draw gas from the fuel header in the correct ratio for efficient, economical combustion. In general, an equally satisfactory control job can be accomplished with either electric or pneumatic controls on a gas installation, but for the purposes of this illustration, the pneumatic type will be described first.

Proportioning or throttling pneumatic control permits the valve to assume an infinite number of positions to provide a steady heat input, depending on demand. The control element is equipped with a bleed nozzle and a flapper which cause the *control* air pressure in the system to vary from 3-15 psi, and, in this way, to vary the opening of the control valve. These pressure changes are exerted on a diaphragm motor valve which opens or closes accordingly.

Since application of the *complete* air pressure change on the diaphragm would cause an initial excessive change in valve position, this pressure is *throttled* so that for each temperature change a proportioned change in control air pressure is provided.

The percentage of the full air pressure change exerted in this way is determined by the setting of the control unit proportional band. Various control units are available which provide either narrow or wide band proportional action. These include: the Brown *Throttlor* controller, with adjustable 1-10% proportional band; the Brown *Full Throttlor* controller, with adjustable 1-150% proportional band; and the Brown *Air-O-Line* controller (see Fig. 2) with adjustable 1-150% proportional band.

As shown in the schematic drawing, this type of controller provides a modulated fuel input to hold a constant temperature. It affords closer control than the simple on-off or two position type controller which operates between full-open and full-closed positions or on a high-low basis to hold *average* temperature conditions constant.

In addition, proportioning controllers give a straight line record of temperature as compared with the *sine wave* effect of the two-position type. As a result, they are recommended where extremely close control is desired or where a considerable amount of process lag or time between temperature change and controller response exists.

Reset Refines Controller Action

As an additional requirement in proportioning control, the means for manual or automatic reset is provided. This function is necessary in those applications which are subject to frequently changing conditions.

It is the function of reset to shift this pen to air pressure relationship either up or down scale and thus maintain desired temperature values in the process. Manual reset, available on Brown *Throttlor* and *Full Throttlor* controllers, is used on installations where these load changes are infrequent or of little consequence. Automatic reset, avail-

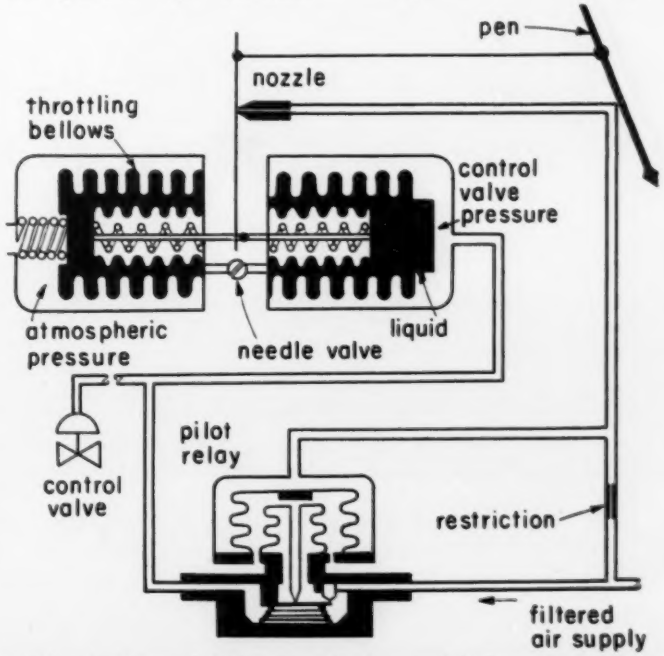

Fig. 2—Schematic Diagram of Air-O-Line control unit as used in Brown pneumatic controllers.

able on Brown *Air-O-Line* controllers, is used on the more difficult installations.

Electric Control Provides Sensitive Action

A large number of electric control forms also are available for highly-sensitive control action on heat treating furnaces. These forms provide all stages of control refinement from simple on-off and two-position contact control, through intricate multi-zone control, to dependable proportional control. Available on both millivoltmeters and potentiometers, this type of temperature regulation makes possible almost any combination of accuracy of measurement, sensitivity of control, and economy of space and money.

Electric proportioning control is available for two types of action, position-proportioning and time-proportioning. The position-proportioning system—available only in potentiometers—was the original type of proportioning control, and was designed especially for gas-fired installations. It is available in two models, position-proportioning control with manual reset, and *Electr-O-Line* position-proportioning control with automatic reset.

Time-proportioning control, originally designed to provide proportioning control for electric furnaces, can be used to advantage on gas furnaces, as well. Available for millivoltmeters in Pulse *Pyr-O-Vane* controllers or for potentiometers in the integrally-mounted *Electr-O-Pulse* control unit, this type of control affords the means of applying the sensitivity and accuracy of proportional control to processes which require that input be supplied only at full, or at high-low values.

In general, while electric control forms are applicable to the same types of processes as the pneumatic control forms, electric control will provide definite advantages over pneumatic control in some types of installations. The determination of which controlling means is best suited to a particular application can be done most reliably in an on-the-spot analysis by a trained application engineer, but an illustration will serve to clarify this point.

Turbulence Gives Optimum Heat Distribution

A problem often encountered in those installations utilizing large, wide, heat treating furnaces is the difficulty in affecting complete heat distribution throughout the furnace. Aside from the possibility of uneven application of heat, there is also the possibility of disrupting furnace atmosphere.

In such an application, the use of a Brown *ElectroniK* recording or indicating controller with an integrally - mounted *Electr-O-Pulse* time-proportioning relay will provide the solution.

This type of proportioning action, with its varying periods of "full-open" and "full-closed" valve, will produce a pulsing flame which

(*Continued on page* 39)

60% savings

S & W "A" type furnace used in conjunction with S & W Ammonia Dissociator. Sloping inlet and exit hoods prevent infiltration of air and keep atmosphere consumption at a minimum.

"A" TYPE CONVEYOR FURNACE

Bright annealing or brazing are obtained with atmosphere savings of better than 60%. A comparable horizontal type conveyor furnace that required 600 CFH used approximately 125 CFH in the sloping hood model. With the alloy muffle, the "A" type furnace assures "high production" bright annealing, hardening and brazing to stainless steel processors.

Doors Open 8" Above Belt!

S & W "A" Type Furnaces now used to bright copper braze stainless steels have 8" clearance above belt — contradicting usual belief that working height of constantly opened furnace doors must be less than 3" to get bright work. Ask about other ingenious installations.

Write today for details on S & W Full Muffle "A" Type Conveyor Furnaces. State your regular requirements — we'll advise without obligation.

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Atmosphere Generators • Ammonia Dissociators • Gas Conditioning Equipment
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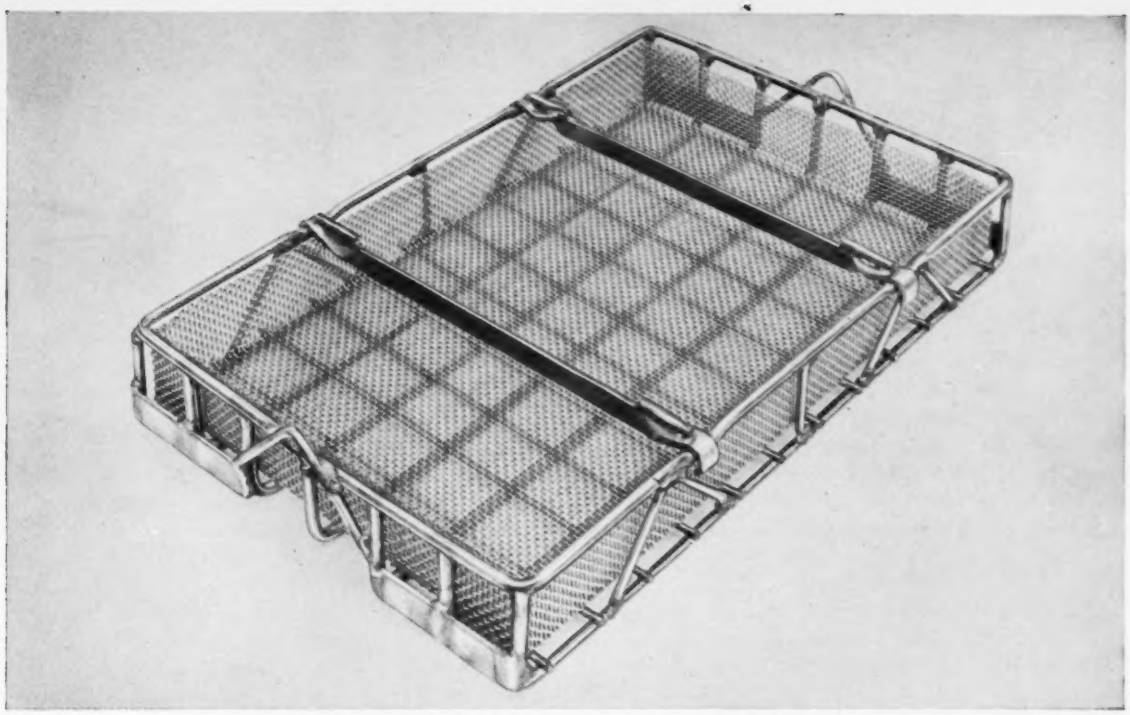


Easy-to-handle, long-life Inconel carbo-nitriding basket developed for use in Ipsen batch carbo-nitriding furnaces by Rolock Incorporated, Fairfield, Conn. Cross-braces are removable — used only when baskets are double-decked in furnace.

Through Inconel... ROLOCK designs lighter, more durable carbo-nitriding baskets for IPSEN furnaces

Today, a lot is being done with Inconel® to develop lighter, stronger and more durable heat treating equipment and fixtures.

Here's one promising example, so new that field tests are still incomplete... A Rolock carbo-nitriding basket for Ipsen batch type furnaces. The design takes advantage of *three* Inconel properties.

Inconel retains good strength up to 2100°F. Rolock exploits this property in two ways. Using minimum diameter Inconel rod, welded, they obtain a light but rugged frame good for medium and large parts. Using an open-mesh, woven Inconel screen, they construct a replaceable inner liner to contain small parts. The result: maximum pay load, minimum weight. Strength enough for stacking, as well.

Inconel resists carbo-nitriding and high temperature corrosion. This is an Inconel property that Rolock passes along directly to its customers. Because strong, tough Inconel has longer "hot" life, they can design for maximum practical life with minimum practical weight.

Inconel withstands severe thermal stressing without cracking or spalling. High "hot" strength, low coefficient of expansion, and the formation of a tight protective oxide, give Inconel high value in properly designed fixtures and equipment. In complex structures, these Inconel properties prevent premature distortion or cracking even after severe thermal shock. In this instance, Inconel helped Rolock build a lighter, more durable carbo-nitriding basket.

"Keeping costs down when temperatures go up"... is an Inco booklet that's packed with ideas for applying Inconel's properties and devising improved heat treating equipment. Write for a copy, today.

The INTERNATIONAL NICKEL COMPANY, Inc.
67 Wall Street New York 5, N. Y.

Inconel... for long life at high temperatures

INCO Nickel Alloys
TRADE MARK

For further information circle No. 9

COMMERCIAL BRIGHT HARDENING OF STAINLESS STEELS

By **FRED HUNTER,** *General Manager*
The Syracuse Heat Treat Corporation
Syracuse, New York

Heat treating high alloy steels has always presented problems to the metallurgist and the heat treater. Although the metallurgy of these alloys is now fairly well known, the mechanical phases are still troublesome. This is primarily due to the fact that the heat treatments of stainless steels, including the austenitic (annealing) and martensitic (hardening) types require temperatures as high as 2000F. At these high temperatures, scaling will occur without proper surface protection. The amount and type of oxidation that is formed depends on the type of heating method used, composition of the atmosphere in the furnace, and the type of processing cycle involved.

When open-fired furnaces are used, a heavy scale is produced and it requires a lengthy and costly pickle, in acid, for complete removal. A "cracked gas" atmosphere when used in the furnace heating chamber will also produce a thin scale or an oxide discoloration that requires descaling pickling, sand blasting or machining if a bright metal surface is desired. In actual practice, it has been found that any type scale, when formed on stainless steels, is more difficult to remove than the same type formed on the more commonly-used carbon steels.

The removal of this scale is, of course, a costly, time-consuming operation and often impairs the potential corrosion resistance and dimensions of the work. The former is due to the fact that mechanical or chemical cleaning tends to upset the delicate balance of alloying elements on and near the surface of the metal. The ideal condition would be the ability to process parts that would remain continually scale-free; that is, a part that is as clean and bright after heat treatment as it was before.

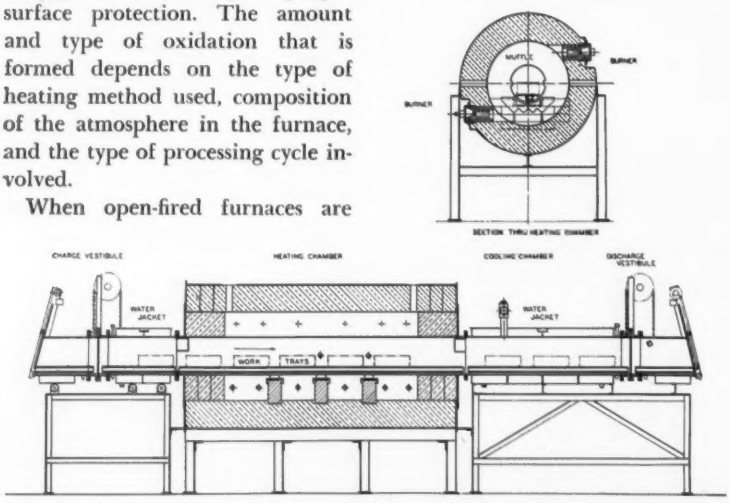


Fig. 1—Cross section of muffle furnace showing charge and discharge vestibules, full muffle heating chamber and water jacketed cooling chambers. Note arrangement of burners and muffle in transverse cross section.

In practice it has been found that this ideal "bright heat treating" is practical in special controlled atmosphere furnace equipment. It is often the only answer for parts with "blind" holes or recesses which are practically impossible to clean thoroughly by chemical or mechanical methods.

This demand for bright heat treating of special steels *at a reasonable cost per pound of work treated,* induced Syracuse Heat Treat to investigate thoroughly the process and equipment potentialities for this market. It was found that an appreciable percentage of stainless work was being processed in the area by the conventional and costly heat treat-cleaning method. It was also found that there existed a market segment in which bright hardening could permit "upgrading" of alloy specifications to achieve an improvement of product at no increase in cost. This is accomplished through the elimination or marked decrease in cleaning operations required.

It has since been found that often these costs are less than before. In the case of some tools and dies the result is a premium product that can obtain a higher price because of marked increase in production life.

High Temperature Muffle Furnace

To provide dependable quality service, Syracuse Heat Treat purchased a 'Surface' Bright Hardening furnace from Surface Combustion Corporation, Toledo, Ohio. It

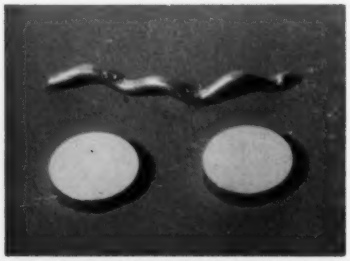


Fig. 2—Samples of type 440C stainless steel as removed from the furnace cooling chamber. Note bright finish. The clean wire shown here was coated by heavy oxide before heat treating in the muffle furnace.

is a high temperature, controlled atmosphere, muffle furnace incorporating charge and discharge vestibules, refractory lined heating chamber with full muffle and water-jacketed cooling chambers. Vestibules are equipped with inner and outer doors to minimize atmosphere loss during charging and discharging. (See Fig. 1) The heating chamber contains an Inconel muffle of circular cross section. This shape is ideal since it reduces thermal strains to a minimum and thus increases overall muffle life.

Prepared gas atmosphere which completely fills the muffle and the cooling chambers and vestibules, is produced by dissociating ammonia gas in an automatic generator. The resulting gas has a composition of 75% hydrogen and 25% nitrogen. A dewpoint of –58°F is maintained at the generator for most production requirements.

Stainless and Tool Steels Treated

All types of stainless steel of the hardening and annealing grades are processed. The furnace has also proved ideal for any air hardening grade of steel. (See Fig. 2) This work consists of tools, dies, gears and other miscellaneous parts for high strength and corrosion resistance and many applications requiring high dimensional stability.

The processing cycle varies according to type and size of part being heat treated. Required furnace temperatures range from 1600-1950F. Gross production rates at 1850F average about 60 lbs. per hour with a cycle involving 5 hours total time in the furnace.

This typical cycle of operation requires that a new tray of work be pushed into the charge vestibule every 30-35 minutes depending on density of work load and metallurgical results desired. When a new load is to be charged at the beginning of each cycle, a bell rings and a light flashes to alert the operator.

The operator first withdraws a trayload of work from the water-jacketed cooling chamber, moving it into the discharge vestibule. Before the inner door is opened and the tray is pulled into the vestibule by a long rod, this chamber is "purged" with atmosphere gas. The atmosphere is then burned off before the tray is removed. (See Fig. 3) At this point, trays have been cooled to a temperature of about 150-160F. The operator next advances the remaining trays one position to make room for a new tray load in the charge vestibule.

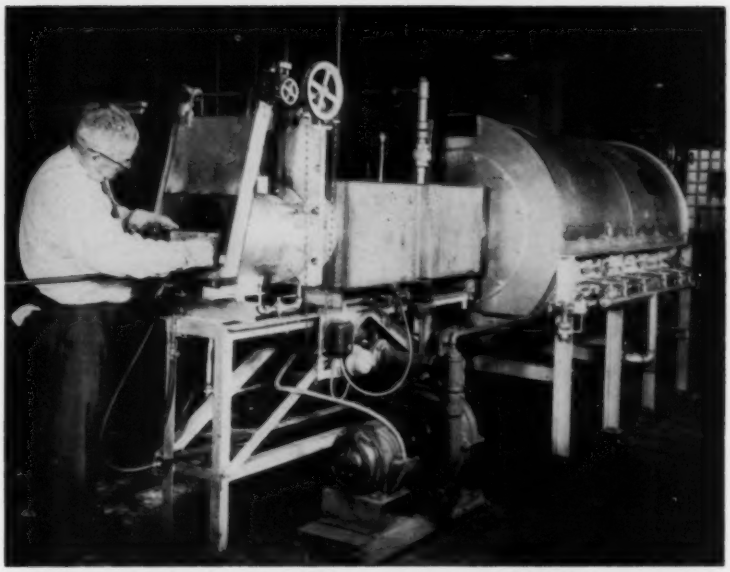


Fig. 3—Operator withdrawing tray from discharge vestibule after completion of cycle. Note water jacket cooling chamber and inner and outer doors of discharge vestibule.

The new tray is placed in this vestibule and the chamber purged with atmosphere gas before advancing the tray into the ready chamber. This cycle is repeated continually as the trays advance through the preheat and high heat zones of the heating chamber and through the cooling chamber to the discharge vestibule. Only one operator is required at all times.

Before charging each new tray load of work, all parts are cleaned of dirt, grease, etc. in a vapor de-

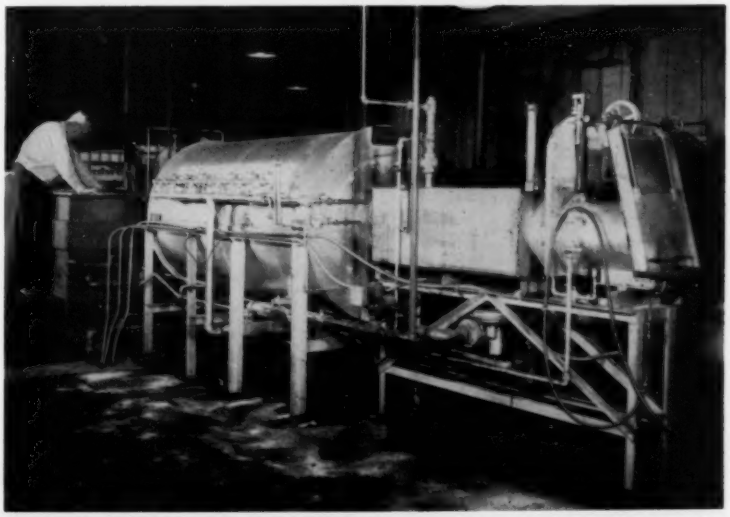
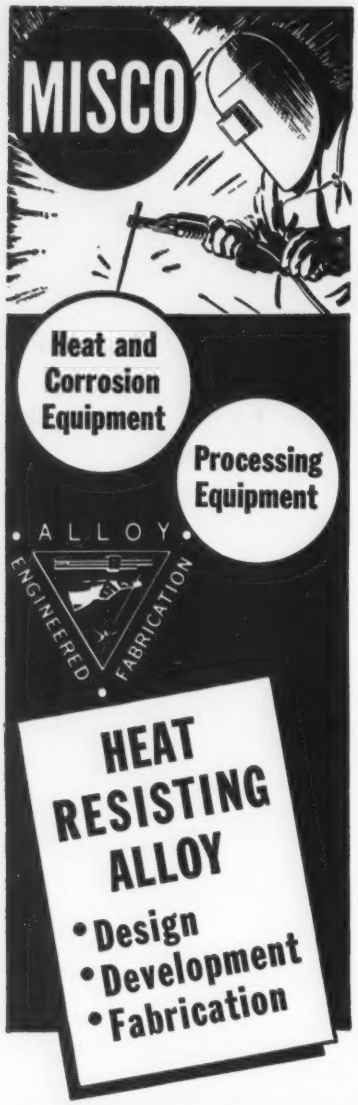


Fig. 4—A new charge, in its tray, is being cleaned by operator in a vapor degreaser. All work is cleaned in this manner before charging into the furnace.



For further information circle No. 10

greaser conveniently located near the charge end of the furnace. (See Fig. 4)

When fully loaded the furnace can hold 11 trays:

Section of Furnace	Trays	Effective Size	Overall Length
Charge Vestibule	1	1' 6"	4' 1"
Ready Chamber	1	2' 0"	
Heating Chamber	2 3	5' 5" wall to wall	8' 1"
Cooling Chamber	3	4' 0"	
Discharge Vestibule	1	1' 6"	6' 7"
Total	11 Trays		18' 9" Overall Length

Each Inconel tray measures 8" x 12" x 4" high, weighs 7 lbs. and holds about 27 lbs. of work.

To achieve a uniform temperature in the heating chamber, automatic proportioning, gas-fired tunnel burners are situated to fire above and below the muffle without directly impinging on it. (See Fig. 1) By dividing these burners into two banks, one on each side, a swirling action is imparted to the heated products of combustion. This swirling action around the muffle heats it uniformly across its width and along its entire length.

A unique feature of this furnace is its ability to go "on-the-line" immediately after coming to temperature. It is not necessary to "condition" the muffle by removing any residual oxygen with several hundred pounds of scrap material, as is often the case with furnaces of this type. As soon as atmosphere has completely filled the furnace muffle, the first tray load can be charged. The work in this tray will come out bright and clean.

To assure quality control at all stages in processing, hardness checks are made from each tray load of work. Hardnesses are also checked after tempering. Standard practice involves checking 10% of all production in this manner.

No Rejects Due to Furnace Operation

Since this furnace was placed in operation over a year ago, there have been no rejects due to furnace operation. Customers have accepted all production when material was correctly specified. In many of these cases, considerable savings and product improvements have resulted from bright heat treating stainless and other steels in this furnace.

One manufacturer has been able to eliminate a costly electroplating operation. Another manufacturer has been able to reduce extremely costly hand stoning operations, required on a special jewelers gear, from 30 minutes to 5 minutes because of the bright finish obtained. A manufacturer of precision parts has been able to save $1.87 per part by changing to this bright hardening method. Tighter specifications have also resulted due to considerably reduced distortion and a final polish has been eliminated. Where 96-144 hours were previously required for delivery, finished heat treated parts can now be delivered in 48 hours. One of the tool steel salesmen in this area merchandises his air hardening die steels in conjunction with the ultimate properties available through heat treatment in this particular furnace.

All of these outstanding examples emphasize the tremendous advantages and the unlimited possibilities gained from the bright heat treatment of stainless type steels. They also point up the practicability of the high temperature gas-fired muffle furnace. The high efficiency and versatility of this type of furnace have made it equally valuable for either large scale or job lot production. It can be an extremely valuable quality tool for the heat treater by improving the overall heat treat production picture. It also upgrades the commercial shop and considerably increases its area of effectiveness. ■ ■ ■

NOW

a high-speed Quenching Oil that gives all-purpose performance

Here's why metal-working plants everywhere are changing to Shell Voluta Oil 23

1. **High cooling rate through the critical temperature range.** To develop maximum physical properties, various carbon and low alloy steels require higher cooling rates than provided by conventional mineral type quenching oils. Shell Voluta Oil 23, because of its initial cooling rate, helps develop these desired properties in such steels.

2. **Versatility of Use.** Shell Voluta Oil 23, because of its high cooling rate, helps to obtain uniform properties with any steel of variable hardenability. It works equally well at normal (120-150°F) oil temperatures and in hot-quenching operations with oil up to 250°F.

Quenching from cyanide into Shell Voluta Oil 23 gives exceptionally clean part surfaces . . . often eliminates the need for after-quench cleaning.

The cooling rate of Shell Voluta Oil 23 is high through the critical range, while its rate of cooling during martensitic transformation is essentially that of conventional oil. This combination is ideal for minimizing distortion tendencies.

3. **Stability in Service.** Extreme resistance to sludging and viscosity change has been achieved through the careful selection of well-refined base stocks and the use of special additives. Shell Voluta Oil 23 stays the same physically AND retains its high cooling rate. *Write for further details.*

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SHELL

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Facilities of . . .
COMMERCIAL HEAT TREATERS
can cut YOUR costs

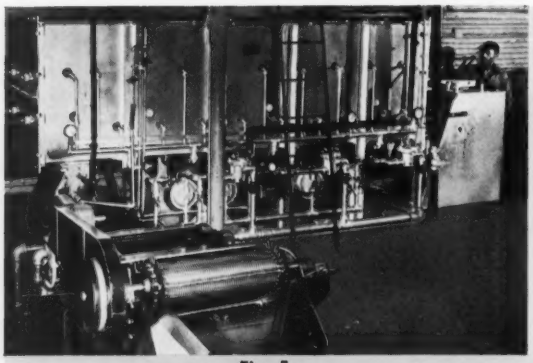

Fig. 1

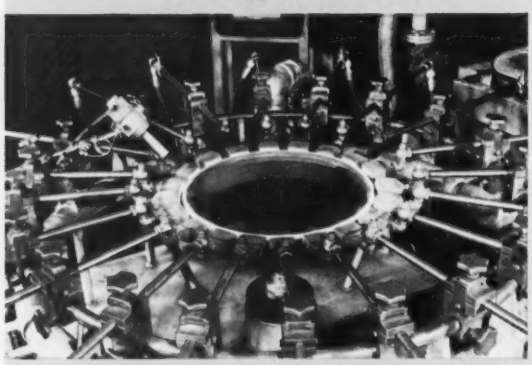

Fig. 2

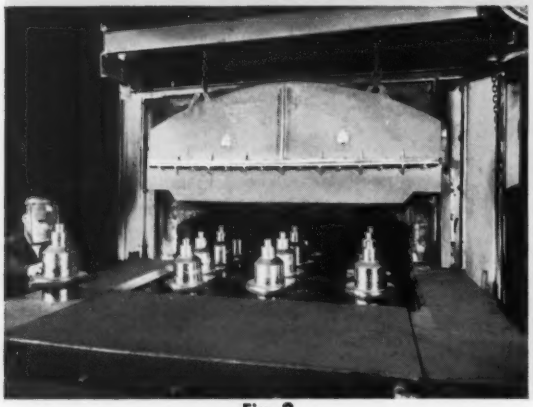

Fig. 3

An MTI commercial heat treater is located near you and is ready to serve your needs by performing "Custom-tailored" heat treating operations.

Because all members of the MTI are specialists with complete service facilities centralized in one plant, they are equipped to offer you a variety of heat treating processes—atmosphere hardening, carburizing, nitriding, annealing, cyaniding, etc.

For example, Fig. 1 shows an installation of a shaker hearth furnace with a continuous automatic quenching tank and a conveyor to a washing machine.

Fig. 2 illustrates a gas flame hardening unit featuring accurate temperature control and using two semi-circular gas manifolds mounted on movable carriages with 20 or more burner heads.

A further example of versatile and dependable equipment found in a commercial heat treating plant is seen in Fig. 3. The specially designed furnace conveyor belt carries over 35 lbs. per sq. ft. in normal service and sometimes as much as 5000 lbs. are loaded on it with pieces ranging from ½ lb. to 100 lbs. and temperatures up to 1650°.

Possessing such equipment together with many other specialized facilities and employing the trained personnel with technical knowledge and experience is the business of the commercial heat treater. Teamwork between him and the manufacturer can cut *your* costs.

Get in touch with the Metal Treating Institute or any MTI member listed on the facing page when you need heat treating services.

WRITE FOR *the MTI booklet called:*

"STRATEGIC USE of OUTSIDE HEAT TREATING FACILITIES CAN CUT COSTS."

METAL

271 N

For further in

Consult any of these HEAT TREATING SPECIALISTS

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ook Induction Heating Co.
4925 East Slauson Ave., Maywood
exter Metal Treating Co.
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ndustrial Steel Treating Co.
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Chicago Steel Treating Co.
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Commercial Steel Treating Corp.
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Commonwealth Industries, Inc.
5922 Commonwealth Ave., Detroit 8
Michigan Steel Processing Co.
3120 Denton, Detroit 11
Standard Steel Treating Co.
3468 Lovett Avenue, Detroit 10
Vincent Steel Process Co.
2424 Bellevue Ave., Detroit 7
State Heat Treat, Inc.
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American Metal Processing Co.
12000 East Nine Mile Road, Van Dyke

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Benedict-Miller, Inc.
Marin Ave. and Orient Way, Lyndhurst
Bennett Heat Treating Co., Inc.
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L-R Heat Treating Co.
107 Vesey St., Newark 5
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Metro Heat Treat Corp.
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NO.5 in a series of ALUMICOAT APPLICATIONS

For HIGH TEMPERATURE APPLICATIONS

Alumicoat

Molten Aluminum PROCESS

CAN PROTECT HEAT TREATING EQUIPMENT FROM CORROSION & HEAT OXIDATION!

The new, ALUMICOAT molten aluminum Process has been perfected to give steels added resistance to corrosion and heat oxidation where continuous high temperatures are a problem.

In the ALUMICOAT Process, heat treating fixtures, trays, etc, are dipped in molten aluminum to produce a metallurgical iron-aluminum bond at the interface and a surface overlay of pure aluminum. At temperatures exceeding the melting point of aluminum, the aluminum on the surface diffuses. This diffused coating, together with the iron-aluminum bond, provides a refractory material that gives steel maximum protection against high temperature scaling.

The ALUMICOAT Process can give you greater economies through the use of lighter yet more rugged fixtures with a longer life through added resistance to corrosion and heat oxidation!

Send for full details. Your inquiry is invited.

ARTHUR TICKLE ENGINEERING WORKS, INC.

29 Delevan Street MAin 5-4200 Brooklyn, N. Y.

For further information circle No. 13

UNUSUAL COMMERCIAL PLANT

(Continued from page 13)

Operation and Maintenance

Three shifts of four men, a heat treat supervisor and three helpers, operate the plant on a full schedule. Two metallurgists supervise all work and are responsible for quality control.

A detailed record of all work is maintained for control and billing purposes. The control system actually begins before parts ever reach the plant, starting with a Quotation Form on which the part name, size, treatment, quantity, etc., are recorded for estimating. As soon as a Purchase Order shipping notice is received, data is transferred to a Master Control Card bearing a number corresponding to a Shop Order Form. Shop Orders are then prepared by the Quality Control Metallurgist, in duplicate. Upon completion of all work, the duplicate copy of the Shop Order is returned to the office for billing.

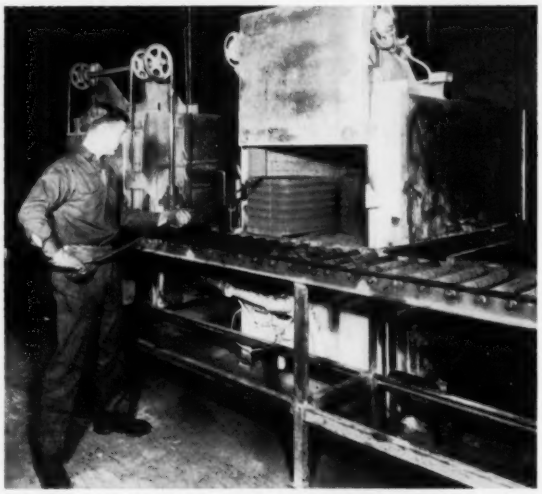


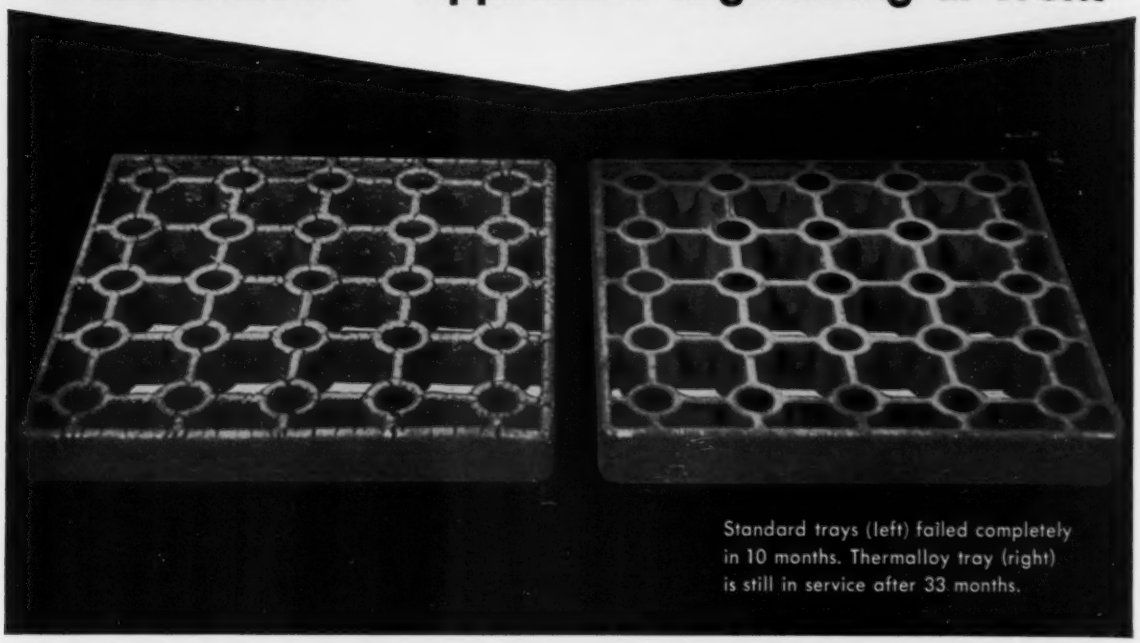
Fig. 4—Part of a battery of tempering furnaces.

Furnace Control Sheets are used to record temperature, time, and atmosphere conditions for work covered by the Shop Orders. These sheets are used for reference for each new batch of material to assure accurate duplication of procedure and results. Upon completion of work, Quality Control Histograms (plot of test results throughout a batch) are used to record hardness, depth of case, etc.

Wherever possible, handling is eliminated to allow operators additional time for checking equipment, maintaining records and general good-housekeeping. A lift truck services all areas of the plant, and steel boxes are used extensively for temporary storage.

Maintenance is simplified since many furnace parts are interchangeable. One maintenance man looks after most of the work which is largely preventive maintenance. Operators are very conscious of the need for maintaining equipment and do a great deal to eliminate unnecessary wear and damage. ■ ■ ■

THERMALLOY* Application Engineering at Work



Standard trays (left) failed completely in 10 months. Thermalloy tray (right) is still in service after 33 months.

A SPLIT RUN PROVED OUR POINT!

Electro-Alloys offers engineering advantages unique in the high alloy field . . . because an experienced staff of engineers and metallurgists is available to help you design longer lasting heat-treat parts in Thermalloy.

Here's how our staff helped a large automotive manufacturer realize longer service from heat-treat trays used in carburizing service followed by oil quenching. Shown above are two types of trays used. One was of standard analysis. And the other tray was cast in a special analysis of heat-resistant Thermalloy . . . recommended by our staff after a careful study of job requirements.

We suggested that a split order of both trays be placed in identical carburizing service. The split run proved our point . . . the standard tray failed completely in 10 months, and the Thermalloy tray is still in service after 33 months.

Electro-Alloys engineering and metallurgical know-how has made a substantial difference in the life of many heat-treat and furnace parts. Can we help you? Call our nearest representative or write Elyria for Thermalloy General Catalog, T-225.

Constant research improves Thermalloy. Here, in tensile testing section, a strain indicator helps measure performance of Thermalloy up to the breaking point.

*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION

6003 TAYLOR ST., ELYRIA, OHIO

Sales offices in: Los Angeles, Oakland, Chicago, Detroit, New York, Cleveland, Philadelphia, Pittsburgh

For further information circle No. 14

DIRECT MEASUREMENTS OF INDUCTION HEATING TEMPERATURES WITH L&N RAYOTUBE® DETECTOR

By **J. L. GARRISON,**
Leeds & Northrup Company,
Philadelphia, Pa.

Induction heating is a process in which a workpiece (capable of conducting an electric current) is heated in a magnetic field produced by an inductor carrying alternating current. In effect, the workpiece acts as the short-circuited secondary coil of a transformer, and the eddy currents induced in the workpiece heat it rapidly.

In recent years, induction heating has been used more and more for such applications as hardening, forging and annealing of steel and high temperature alloys. Control of product temperature was usually determined by time or speed: in batch processes, by timing the length of the heating cycle; in continuous processes, by controlling the speed at which the work passes through the induction coils.

These methods, relying as they do on an indirect measurement, have serious limitations. Any slight error in speed or time is amplified into many degrees of temperature error. In addition, the induction heating equipment itself can produce errors due to such changing conditions as variations in line voltage or frequency, changes in position of the work in the coil, and variations in generator efficiency due to aging of its components. Moreover, the proper heating cycle for each different product must be determined by a tedious trial and error method and even then is not reproducible under changing conditions.

With the growth of induction heating came the demand for an accurate method of direct temperature determinations during the heating cycle. To meet this demand the Leeds & Northrup Company developed a small-target, high-speed Rayotube® detector for direct temperature measurements from 1100°F. up. When mounted four inches from the induction coil, it can focus on an opening as small as 0.1″ between turns of the coil, and through this opening sight on the hot surface of the work. It can operate with instrument housing temperature as high as 350°F. without affecting these readings. When suddenly exposed to radiation of a workpiece, the Rayotube will detect 99% of true temperature within 0.6 second. When measuring the temperature of the work during a heating cycle, it follows work temperature with a maximum time lag of only 0.15 second.

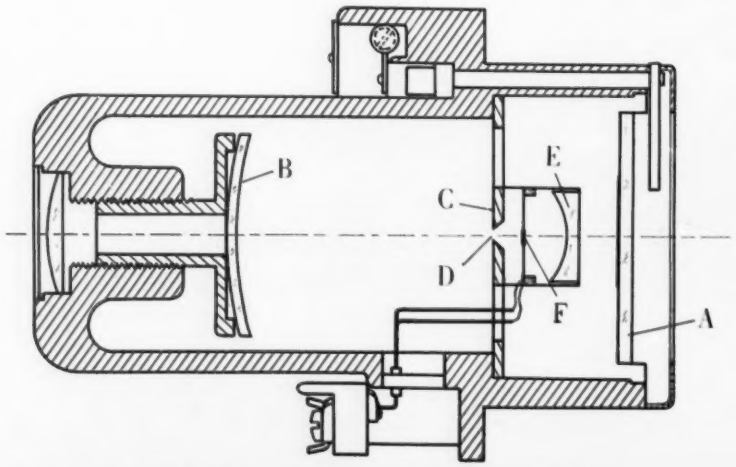


Fig. 1—A diagram showing the construction of the L & N Rayotube detector.

Construction

The Rayotube consists essentially of a hermetically sealed, nonferrous housing enclosing a double mirror optical system which focuses the radiation received from a hot body or emitter on a small, sensitive thermopile which, in turn, produces an emf proportional to radiation received. Unusually sturdy, the Rayotube provides years of service . . . is unaffected by shock, vibration or gas fumes.

Fig. 1 shows its construction. Radiation from a heated workpiece enters the quartz window A, is reflected by the spherical mirror B, and is brought to a focus on diaphragm C in the center of which is an aperture D. Radiation passing through D is reflected by the spherical mirror E to the receiver or thermopile F where an image of D is formed. The emf generated by the receiver becomes a reliable index of work temperature and is continuously measured by a Speedomax® G instrument, calibrated in temperature.

Recording-Controlling

Besides providing a record of work temperature, the Speedomax

recorder can also control the temperature of the workpiece either by regulating the time or speed of the workpiece in or through the coil, or by regulating power input to the induction coil.

A simplified circuit diagram of the Speedomax G measuring circuit is shown in Fig. 2. The standard cell SC is automatically switched into circuit at regular intervals; checks potential drop across slidewire S; and if battery output needs adjusting, rheostat R contact is automatically repositioned. With the current thus standardized, Rayotube emf is easily balanced against the potential drop across slidewire S contact and X.

The potentiometer used to measure Rayotube emf contains a major modification of the standard potentiometer. This is the introduction of slidewire S2 to provide emissivity compensation. A theoretically perfect emitter has a factor of unity; all practical emitters (except under special conditions) have a factor less than one. This value is dependent upon the material and condition of the surface measured and is relatively constant.

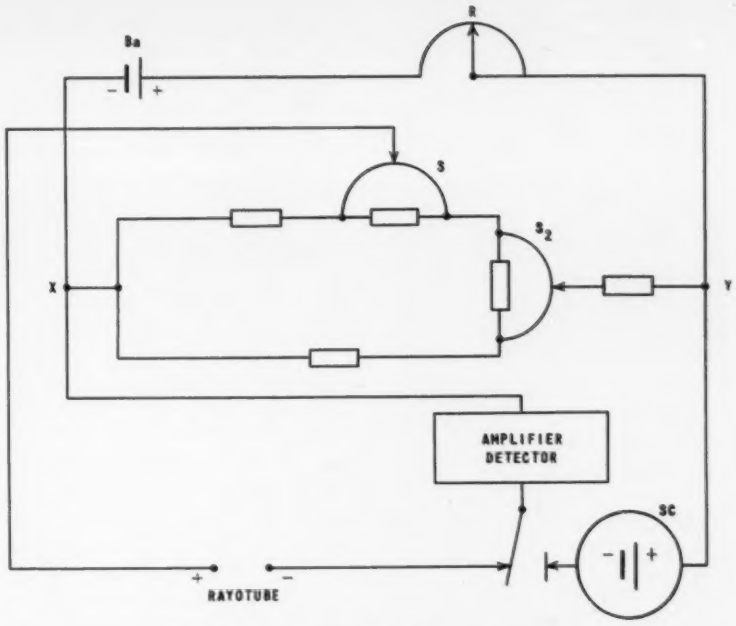


Fig. 2—A circuit diagram of the Speedomax G recorder.

In the circuit shown in Fig. 2, the voltage divider branch x-y is expanded to a parallel circuit, through which current division is determined by S2. Since the Rayotube output is directly proportional to the emissivity for a particular true temperature, the recorder is initially "tuned" to a specific application by manually adjusting compensator S2. Current through the slidewire S branch is reduced where emissivity is low and increased where emissivity is high.

Installation and Operation

The Speedomax and Rayotube are easy to install and operate. Unlike a thermocouple, no compensating extension leadwire is re-

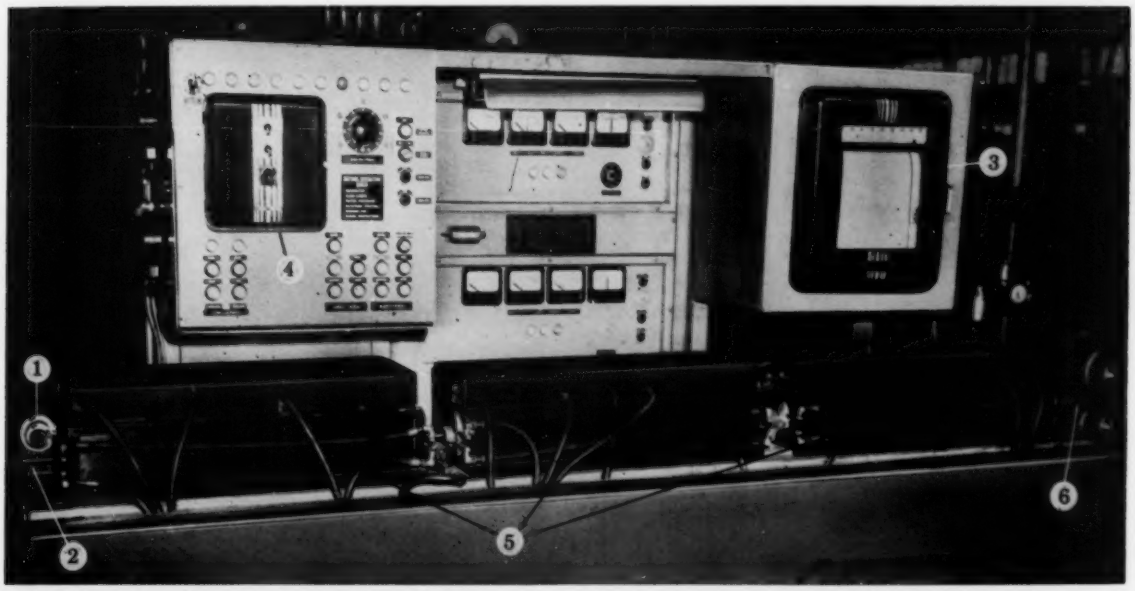


Fig. 3—The Rayotube (1) detects the temperature of heated stock (2) from coils. The Speedomax recorder (3) and the L & N controller unit (4) regulate power to the induction coils (5). The cold bar stock (6) is shown entering coils.
(Photo courtesy of Lamson & Sessions Co.)

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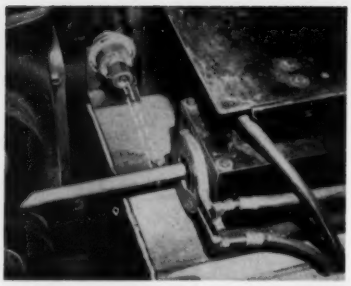
For further information circle No. 46

quired and ordinary copper wire can be used.

Fig. 3 shows a typical installation where the use of induction heating in combination with the Speedomax - Rayotube team enabled a midwest manufacturer of fasteners to increase their nut-forming capacity by 50% and to eliminate rejects due to scale. Round bar stock is first fed into the coils of the 3,000 and 10,000 cycle induction heaters mounted in series. As the hot bar emerges, it moves into a cut-off and nut-forming machine which produces 4200 blanks an hour. The formed nuts drop into an oil quench and are picked up later by a steel conveyor.

Despite changes in line voltage or in the size or composition of the bar or its speed through the induction coils, the equipment's Rayotube detector along with the Speedomax controller keeps bar at uniform forging temperature. The Rayotube sights directly on the hot bar as it emerges from the coils and rapidly follows its temperature changes (see Fig. 4). If temperature is above or below 2350°F., the Speedomax throttles a motor-operated rheostat to regulate power output of the motor generator set to the induction coil and thus keeps the bar at desired heat. ■ ■ ■



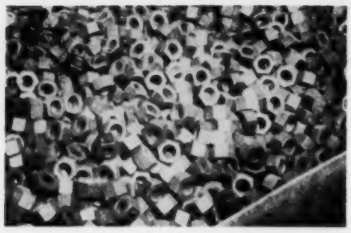


Fig. 4—The Rayotube (left), positioned here at 9" from the bar, can be focused on an area as small as 0.1" in diameter at 4". Because of fast, controlled heating, punched blanks (right) are clean and scale free.

(Photo courtesy of Lamson & Sessions Co.)

New RECIPROCATING HEARTH FURNACE

Patent 2,671,654

Carburizing, case hardening, "Ni-Carb" ammonia-gas carburizing, clean hardening, etc. of parts ranging from balls for ball point pens to heavy forgings can be accomplished in the same model without any modification.

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Representatives in principal cities.

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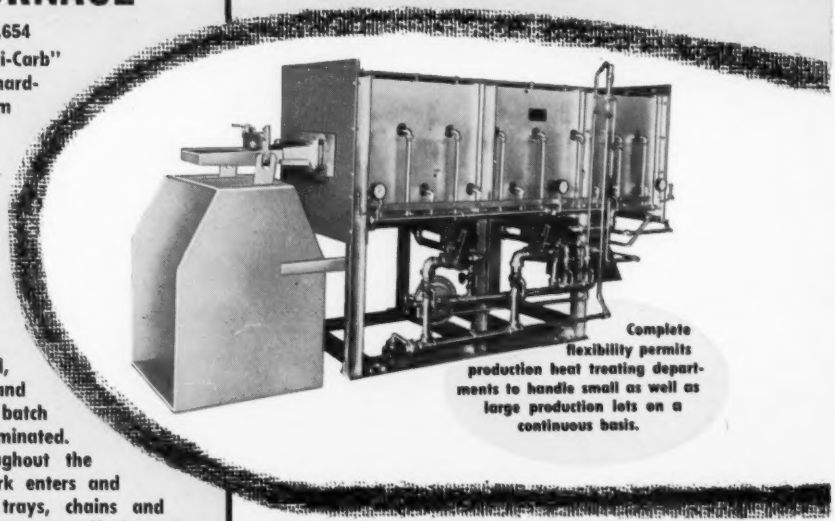

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For further information circle No. 15

LABOR RELATIONS

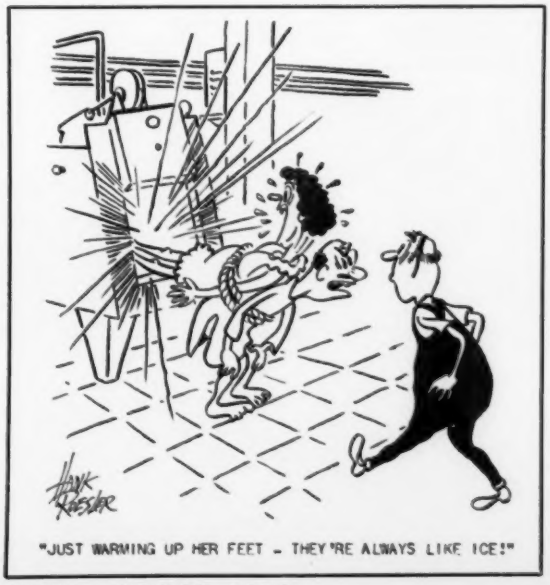
(Continued from page 14)

immediately tramped over to the paymaster and asked, "What gives?"

The paymaster had a ready answer. They didn't work the day after a holiday so they are not eligible for holiday pay. True, there was no work, but that wasn't the company's fault. Other employees had gone out on strike and therefore those who reported had to take the consequences of the illegal stoppage. The company's policy definitely limited the exceptions to "sickness, death in family and good cause." A strike, preventing these men from working was not good cause.

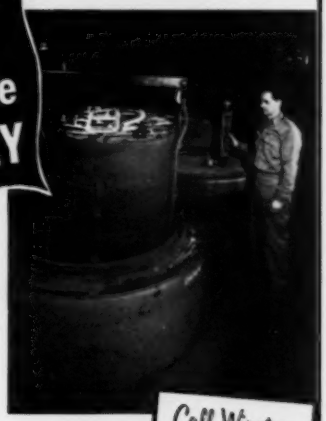
Was Management: RIGHT ☐ WRONG ☐

What Arbitrator Ralph T. Seward Ruled: "The purpose of the holiday pay policy is clear. It is an attack on the perennial problem of pre-holiday and post-holiday absenteeism—an effort to discourage empoyees from stretching a holiday into two or three days absence from work. Its concern is strictly with the individual action of individual employees. At any rate, the arbitrator finds the failure of the employees to work the day after July 4th was for "good cause." None of the workers were themselves responsible for the fact that they did not work their turn. There was no effort to stretch out a holiday, no disregard of working schedules, no failure to fulfill their responsibilities. In so far as was within their power, the grievants did precisely what they were supposed to do to qualify for holiday pay. They came to work. Regardless of the reason for the shutdown, these employees were not responsible for it. The men are entitled to pay for the holiday." ■ ■ ■



"JUST WARMING UP HER FEET - THEY'RE ALWAYS LIKE ICE!"

WIRETEX
Pit Furnace
ASSEMBLY



cuts treating time 50%

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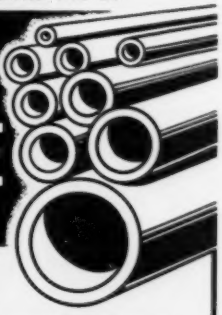
to resist acids, heat, abrasion or exposure. Small, large—standard or custom made in every weave, metal and alloy.

For further information circle No. 16

HEAT RESISTING
ALLOY PIPE
from STOCK



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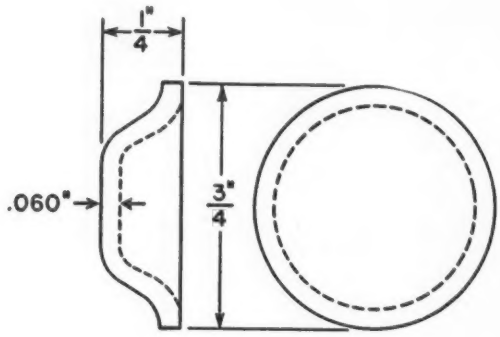
For further information circle No. 17

HEAT TREATING HINTS

Meeting Specifications

John Johnson of Johnson Bros., manufacturers of automotive specialties, was going crazy. He had taken a contract for several thousands of valve caps of a special design.

The specification called for 1075 Steel treated to 64-66 Rockwell C. Anything less than 64 was cause for rejection.



The material was carefully checked for hardenability, producing top hardness from 1475 F oil quench. Since there was a .002" skin of partially decarburized surface, the heat treating was set up: weak cyanide bath, 1525 F. in baskets, oil quench, no draw. Check 5% for minimum hardness—64 Rockwell C.

The first lot of 10,000 pieces was run and sent to inspection and promptly rejected (50 to 65 Rockwell C) approximately 10% of the lot were soft by spot check! The temperature was raised, time was increased, quantities reduced but still the same variation in hardness and consequent rejection.

In order to keep the customer happy, 100% inspection was ordered and that's where John got into the picture: 500,000 pieces @ ½c each, meant $2500—nearly all his profit on the job.

On the theory that the salt stuck in the hole and was not blown out in the quench, a batch was run on pans out of controlled atmosphere, and still another in open fire. Results identical!

Then old Joe was called in—reached back into his bag of tricks—and came up with the solution. The cups nested in baskets or on pans, producing a poor quench, resulting in nonuniform hardening.

Using a belt conveyor or shaker hearth furnace with an atmosphere turned to restore the partial decarb—the cups were spread out in single layers so that no nesting occurred. Result—100% 64-65 Rockwell C and the profit was saved.

Heat Treating Hints
Vol. IX, No. 5
Lindberg Engineering Company
Chicago, Ill.

Heat Treaters' Problems

Here are some problems that are part of a commercial heat treater's work-day with some suggestions for solutions that may prove useful to you.

1. Experience has proven that rolls, blanking and forming dies may have their service life increased by a low temperature draw after a period of use. Such preventive maintenance acts to dissipate the work stresses which eventually lead to fatigue failures.

2. Forging die lubricants carrying graphite should be reviewed where difficulty or failure is being experienced with stainless steel parts subjected to qualifying corrosion tests. The possibility of slight carburization is most prevalent on small thin forgings which cool rapidly and do not have an opportunity to scale-off the surface carbon. The same condition can cause grief in machining—provoking poor surface finish and short tool life, as a result of the unexpected surface microstructure.

3. Trouble may be experienced in holding accurate threads, run-out, etc., on parts made of cold-rolled material subjected to heat treatment. The condition can be minimized at the expense of reduced machinability—by stress relieving the bars at 1100-1150 F. Naturally the economics should be evaluated relative to short or large quantity lots.

4. Large sections of high speed steel should be preheated very deliberately for tempering in order to prevent the possibility of incipient cracks on material which may not have favorable ingot reduction.

5. Marquenched work should be at room temperature before washing to remove quench salts. Early washing can cause violent cracking. Specifically large sections should be carefully screened after salt quenching—because of possibility of incomplete transformation in the mass.

6. Check gear forgings for excessive flash due to die wash—where excessive distortion is being experienced.

Heat Treating Hints
Vol. IX, No. 4
Lindberg Engineering Company
Chicago, Ill.

Editor's Note: *If you have any items of interest, please send them along.*

TITANIUM ALLOYS

(Continued from page 6)

150,000 to more than 200,000 psi are produced. The optimum solution treatment appears to be the 1675°F water quench. This treatment produces the lowest yield/tensile ratio; and on subsequent aging, depending on the time and the temperature, a wide range of properties can be obtained.

The heat treatment of Ti-140A is illustrated by the data in Table VI. These results show that with increasing solution temperature, very high strengths are obtained with loss of ductility. As the beta transus temperature is approached, the alloy becomes extremely brittle. However, subsequent aging at lower temperatures results in an excellent combination of properties which could prove useful in many applications.

Since titanium has a great affinity for oxygen, nitrogen and hydrogen, every precaution should be exercised to prevent surface contamination by these elements as embrittlement could result. This requires use of minimum heating times and temperatures, use of oxidizing rather than reducing atmospheres (to prevent hydrogen pickup) and selection of proper descaling methods. Sodium hydride descaling is to be avoided if hydrogen control to low levels is desired. A salt bath, such as Virgo, is to be preferred.

It is anticipated that the producers and consumers of titanium will rely more on heat treatment for development of optimum properties in titanium alloys in the future. This phase of titanium technology will definitely receive increasing emphasis. ■ ■ ■

SALT BATH CARBURIZING

(Continued from page 10)

section such as this, low distortion is extremely important and the case penetration must be accurate in order to prevent either too little or too much case. Too little case would obviously interfere with wear resistance, while too heavy a case would make the part brittle and likely to fail in service. The prevision carburizing characteristic of salt bath operation was quite important here.

We could continue indefinitely listing individual applications where salt bath carburizing has shown definite advantages over any other method which has been tried, both from the standpoint of reducing costs and in improving quality. There are various applications where any of the other methods for carburizing can be employed to advantage and, of course, the individual job always governs the best choice of method. However, where rapidity of carburizing, accuracy of the finished part, minimum capital investment, versatility, and simplicity of operation must be considered, molten bath carburizing with the modern carburizing compounds will often be found to be the first choice. ■ ■ ■

The

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Annual Achievement Award

To be made at the discretion of a Committee appointed to select the Best Article appearing in Metal Treating magazine or Lecture presented at any meeting of the Institute.

This year's award shall be presented at the 1955 Annual Meeting of the Institute and all Articles appearing in any issue of Metal Treating from September - October 1954 to July - August 1955, or any Lectures presented at the 1954 Annual and 1955 Spring Meetings are eligible for consideration.

Award Committee—

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H. N. Bosworth, *Chairman, Research and Awards Committee*

H. C. Knerr, *Chairman, Publication Committee*

Fred Heinzelman, Jr., N. R. Hodgson, Michael Kober, L. G. Field; *members, Publication Committee*

C. E. Herington, *Editor, METAL TREATING*

NEWS TO HEAT TREATERS...

Titanium Research

The effect of hydrogen on titanium and titanium alloys and an evaluation of cutting fluids for turning this new metal are described in two reports of government-sponsored research just made available to industry by the Office of Technical Services, U. S. Department of Commerce. These research projects were conducted under defense contracts for Army Ordnance.

One of these reports, prepared by Battelle Memorial Institute and describing the effect of hydrogen on the structure and mechanical properties of titanium and titanium alloys, indicates that hydrogen is an impurity which must be kept under close control if the maximum advantage is to be obtained from titanium alloys. The other report, which compares cutting fluids for turning titanium as to their effect on tool life, concludes that the cooling fluids are more effective than oils when temperature is a major contributing factor to tool failure.

For further information circle No. 18

Alloy Surface Diffusion

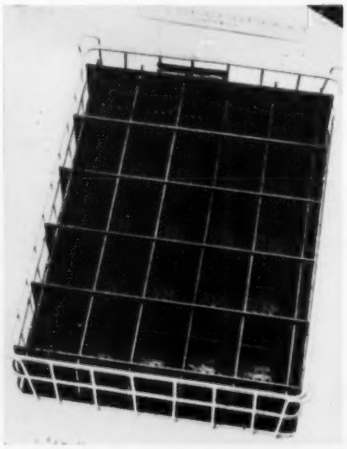
A new process that diffuses chromium into ferrous metals and forms a stainless surface alloy to depths of from 0.001" to 0.008" and more without causing dimensional changes has recently been developed by Alloy Surfaces Company, Philadelphia 4, Pa. It is reported that the process will permit ferrous metals to resist corrosion even under the most severe atmospheric, water and chemical corrosion conditions; resists thermal oxidation even at temperatures to 1700° F. and resists wear and abrasion under a wide variety of difficult applications. The surface will not chip, crack, peel or gall even when the processed product is bent 180°, stretched or twisted.

The process makes available parts and assemblies with resistance characteristics at costs less than stainless steel fabrication, and it has unlimited applications wherever the advantages of stainless steel are required. Specification grey iron and malleable iron castings and Meehanite castings can also be treated to make castings with corrosion resistance properties.

For further information circle No. 19

Degreaser

The degreasing of parts so they are not touched by metal has been reported solved by the Woodward Governor Co., Rockford, Ill., which has developed removable bottoms and divider inserts made of Masonite Tempered Presdwood for wire baskets.



Bottoms are perforated Tempered Presdwood, and the dividers are slotted so they fit together and form an "egg crate" grid. Parts put into the baskets can touch only the hardboard, not each other or the wire basket.

The company uses the hardboard for inserts because it has found it to be the only inexpensive and suitable non-metallic material which is not affected by vapor degreaser fluid.

Divider strops have slots cut in various positions, so that the compartments can be assembled with various sizes and numbers of holes per basket. In general, the assembled baskets are 18" x 24" x 6". Some types have panels with larger holes to hold small cylindrical parts upright.

For further information circle No. 20

Barrel Cart

A new barrel-handling truck, which is said to require no tipping or pick-up space when handling barrels touching each other, has just been announced by Valley Craft Products, Inc., Lake City, Minnesota.

Designated Valley Barrel Cart Model 600, the manufacturer says it is equipped with an automatic spring actuated bar that allows a hook to slip over the barrel edge as the truck is moved against the barrel without the operator touching either the hook or barrel.

Heavy barrels stored in contact with each other can be easily loaded on the truck by a single operator without moving them apart because

of this automatic clamping hook. Special design of the loading shoes provides easy tipping of the heaviest barrels.

The main frame of the cart is said to be ruggedly built from heavy 1" pipe and has a 1" diameter axle. The wheels are equipped with precision roller bearings and 10" x 3" solid rubber tires mounted on semi-steel wheels are recommended for use on smooth floors. Pneumatic tired wheels are also available for movement over rough surfaces.

For further information circle No. 21

New Labeling

Tempil° products are now being labeled with both the Fahrenheit and Centigrade temperature ratings. The laboratory scientist and research man are more likely to

rely on the Centigrade scale. In addition, the Centigrade designation meets the requirements of foreign trade, since the Centigrade scale is the prevailing one almost everywhere abroad.

For further information circle No. 22

Translations Available

Aware that much good literature of value and interest to heat treaters is being published abroad, METAL TREATING has made arrangements with a professional translator to advise us regularly of the availability of English translations of outstanding magazine articles, books, texts, etc., that would be of value to heat treaters. We shall publish such a list in this column in each issue.

The following translations are

ROLOCK
FABRICATED ALLOYS
HEAT AND CORROSION RESISTANT

ROLOCK INCONEL TRAY
FOR USE IN IPSEN AUTOMATIC FURNACES

- Travels easily, smoothly over hearth
- Pickup loops provided for safe handling
- Rugged design for use and abuse
- Live-load basket weight ratio better than 10 to 1
- Longer furnace hours than any known tray
- Lowest cost per hour of use

Rolock engineers have given original and creative thought to improve and standardize this outstanding round rod sled-type tray (pat. applied for). Result: Basket shape maintained indefinitely . . . hour-life greatly extended . . . hour-cost decidedly lowered.

Standard tray weight is 37 lbs. For Ipsen Furnace Models T-400 and T-800 . . . may be used singly or stacked. Stacking bars are used to support upper tray...also to prevent side-slide of tray. Extended-end handles prevent forward or backslide through heat and quench. Maximum temperature is 1750° in carbo-nitriding . . . an easy exposure for this strongly welded, all-Inconel carrier. A replaceable mesh liner screen (also Inconel) is generally used, but is not necessary for large parts.

Trays travel smoothly over the flat hearth, with round bars acting as sleds (easier to push than any other type of tray), without galling the hearth.

This is another instance of Rolock design, construction, and pressure-joint welding that provides superior performance.

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ROLOCK INC., 1232 KINGS HIGHWAY, FAIRFIELD, CONN.

JOB-ENGINEERED for better work
Easier Operation, Lower Cost

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For further information circle No. 23

available from Henry Brutcher, P. O. Box 157, Altadena, California; all are illustrated and all have bibliographies. They may be secured by ordering directly from Mr. Brutcher.

No. 3466—*Pack Chromizing of Steel in a Compound Containing Chromium Sesquioxide;* by G. N. Dubinin, translated from *Vestnik Mashinostroeniya,* 1954 ($3.25)

No. 2570—*Commercial Annealing and Quenching Plus Tempering of Cold-Drawn Steel Bars with Special Consideration of Scaling, Decarburization, Heating Rate and Temper Brittleness,* by W. Hulsbruch, trans. from *Stahl Und Eisen,* 1950. Part I—"Annealing Before and After Cold Drawing" ($14.80). No. 2965—Part II—"Quenching Plus Tempering of Cold-Drawn Steel." ($9.60)

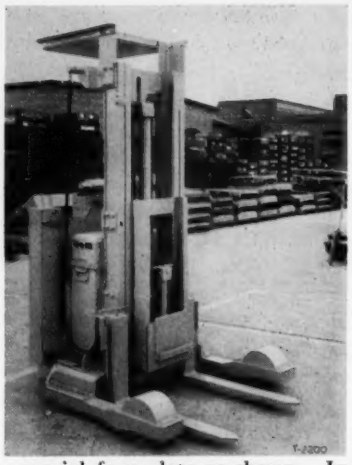
No. 3465—*Residual Stresses Set Up By Flame Hardening,* by H. Buhler, trans. from *Archiv. f. d. Eisenhuttenwesen,* 1954 ($6.80)

No. 3469—*Formation of Graphite on the Surface of Steel During Heat Treating in Vacuum,* by E. Z. Graifer and I. V. Salli, trans. from *Doklady Akademic Nauk SSSR,* 1954 ($2.25)

No. 2330—*Measurement of Temperature of Salt Baths,* by N. I. Brykushin, trans. from *Zavodskaya Laboratoriya,* 1949 ($1.20)

Box Dumping Device

A hydraulically-operated box dumping device has been introduced for "Transveyor" trucks manufactured by the Automatic Transportation Company, Chicago, Ill. it was recently announced. Designed for use with "Dump-O-Matic" or similar loose-bottom boxes used for handling loose material such as scrap or parts in process, the device consists of an extra mast that has been fitted with

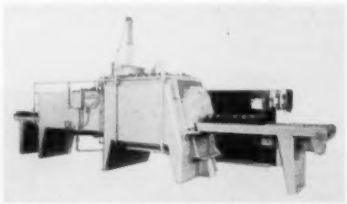


a special face plate as shown. In operation, the forks of the Transveyor are first raised to dumping height; the face plate then engages the lip of the loose-bottom box, and raises it high enough to dump its contents. The attachment is controlled from the operator's position, and operates from the truck's hydraulic system. Capacity of the unit shown is 2,000 lbs.

For further information circle No. 25

Three New Heat Treating Units

Ipsen Industries, Inc., Rockford, Illinois have introduced three new "TFC Series" Heat Treating Units featuring multiple cooling zones for air-cooling of work under protective atmospheres. It is stated that these units now make possible carburizing, carbonitriding, nor-



malizing, annealing, stress-relieving, and brazing operations under complete atmosphere protection to achieve bright, scale-free work.

The "TFC Series" units are classified at 400, 500, and 900 lbs/Hr. at 1500°F. These capacities meet a wide range of production requirements. Maximum weight per charge is 600, 800, and 1400 pounds respectively. Operating temperatures of 1850°F or 2150°F are available.

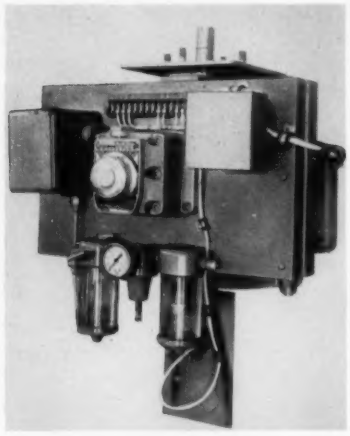
For further information circle No. 26

'PSC' RADIANT TUBES in
Any Design or Dimension
Send for PSC Heat-Treat Catalog 54
PSC fabricated tubes furnish four substantial advantages: (1) Light-wall construction saves furnace time and fuel. (2) Return bends are of same wall thickness as tubes, promoting uniform flow of gas. (3) Smooth dense walls minimize carbon build-up and burn-out. (4) Up to 100% longer life. In any alloy, size or type, including parabolics. Also sheet-alloy heat-treating retorts and covers, boxes, baskets, fixtures, tubes, etc.
PSC
THE PRESSED STEEL CO • Wilkes-Barre, Pa.

For further information circle No. 24

Lift-Rotate and Scanning Spindle

A new lift-rotate and scanning spindle for induction heating is available from the Westinghouse Electric Corporation. The lift-rotate spindle is a work-handling machine for automatically moving parts, gears and shafts through induction heating coils and quenching them, following a pre-set cycle. The maximum work load of the



device is 50 pounds with ¼ cu. ft. of free air per cycle. Power for the ¼-hp "rotate" motor is 220/440 volts, 50/60 cycle, 3 phase with a rotational speed of 145 rpm. Scanning speed range is ¼ to 2 inches per second, with an accuracy of plus or minus two percent for a given setting and temperature.

The spindle can be loaded in the top position above the quench and coil permitting rapid loading and unloading when using a spray quench. It is also applicable to parts requiring submerged quench. Uniformity of heating and quenching is assured by rotation in all heating and quenching positions.

This apparatus is an integral assembly including all valves, piping, terminal board for wiring and sink-mounting plate with gaskets.

Dimensions of the unit below sink and above sink are 26 inches and 9 inches, respectively.

For further information circle No. 27

Pacific Coast Headquarters

Metal & Thermit Corporation has announced that it is establishing new sales headquarters for the Pacific Coast Region in the Los Angeles area. Toward the end of July the company will move its western headquarters into a new warehouse and office building now under construction at 1926 Maple Avenue, El Segundo, California.

The new building will provide warehousing facilities for the products of all Metal & Thermit divisions: welding materials, industrial chemicals, ceramic materials and the plating and coating materials of M & T's United Chromium Division. (See cut)

Erection of the new facilities was made necessary by the expansion of its West Coast activities, Metal & Thermit states. Selection of Los Angeles as the base for its western operations will enable the company to provide better service for its customers in the rapidly growing southern California industrial area.

It was also announced that James L. Oberg has joined Metal & Ther-

To

Those concerned with

QUALITY HEAT TREATING

No other method presently in use can match the uniform heating produced by the recirculation of hot gases.

The flow of hot gases properly channeled through the work in sufficient volume constitutes the most efficient heating obtainable.

Temperatures from 300°-1800° F. can be held within extremely close limits.

Homogeneous penetration of carbon in carbonitriding and carburizing is accomplished by the use of effective recirculating fans.

For example: automotive piston pins are carburized to a case depth of .040" to .050" more uniformly and in a shorter time in a furnace in which the active gases are recirculated. This recirculation is produced by special alloy fans.

In lower temperature *"Circ-Air"* furnaces high velocity fans force the hot gases through the work with no temperature head. Thus thin and thick sections heat more evenly. The entire work load comes to heat uniformly. Only in a *"Circ-Air"* furnace heated by recirculation can this type of heat control be achieved.

"CIRC-AIR"

Get More Facts About Recirculation—

Write

↓

INDUSTRIAL HEATING EQUIPT. CO.

3570 FREMONT PLACE • DETROIT 7, MICHIGAN

For further information circle No. 28

mit Corporation in the capacity of Technical Advisor.

In his new position Mr. Oberg

will handle special assignments on metals, Thermit and electric welding processes. He will work with all departments on projects involving manufacturing processes, and will investigate new markets and new uses for existing products as well as potential new products of a metallurgical nature.

For further information circle No. 29

Industrial Marking Tool

A new heavy-duty industrial model of the famous Vibro-Tool has been announced by Burgess Vibrocrafters, Inc., Grayslake, Ill.

Called the V-99, the industrial model Vibro-Tool is an easy-to-use marking device for permanently marking tools, dies, jigs, and other equipment with numbers, company name, or other identification marks. Useful for marking inventory control numbers, name plates, tags, and bin or drawer data. Records inspector's O. K.'s, brands rejects and seconds.

All marks are permanent because they are engraved.

The V-99 Vibro-Tool is equipped with an unbreakable rubber housing and can be used like a pencil on anything made of steel, brass, aluminum, copper, glass, wood, plastics, cast iron, etc.

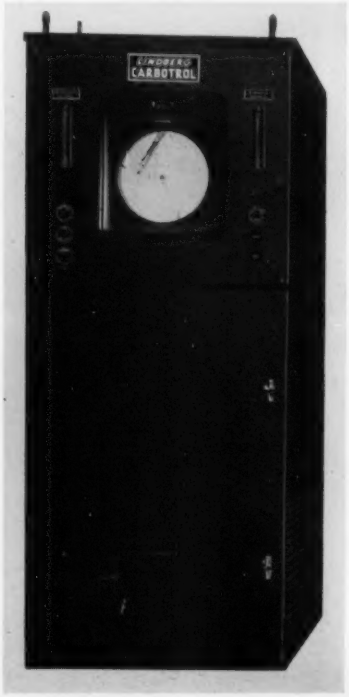
Complete with Hard Tantalum Carbide Point, the V-99 Vibro-Tool sells for $15.95. An accessory Diamond Point is available at $5.95.

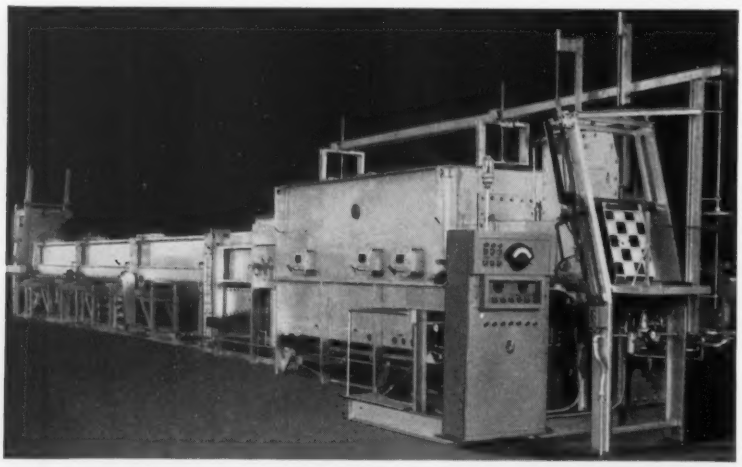
For further information circle No. 31

Automatic Dew Point Controller

A new automatic controlling, recording, and proportioning instrument which enables the heat treater to set his atmosphere generator or furnace in equilibrium with any steel to be heat treated is now offered by Lindberg Engineering Company, Chicago 12, Illinois.

Named the "Carbotrol," the instrument is said to make automatic control of the furnace atmosphere for any type of steel as simple as automatic temperature control of





Harper Automatic Conveyor Belt Electric Furnace with sequence of operations automatically timed and synchronized.

HARPER on **Heat Processing** **Reports to Industry**

Vigorous competition in every field demands engineering that anticipates as well as meets industrial requirements heretofore undreamed of! Your inquiry about Harper Electric Furnaces will be welcomed as a challenge to come up with helpful answers for you,—write today!

HARPER **ELECTRIC FURNACE CORP.**
51 River St. Buffalo 2, N. Y.
Furnace Builders for Over 35 Years
Representatives in Principal Cities

For further information circle No. 30

Metals "Custom-Tailored"

(Continued from page 18)

generally sets up a turbulence in the furnace. In this way, optimum heat distribution throughout the furnace can be provided.

Since it would be impossible to cover adequately the vast subject of instrumentation for heat treating processes in a single article, it is sincerely hoped, instead, that this article will serve to scratch the surface at least of that sizable portion in itself pertaining to temperature control. If it will prompt further investigation into the numerous and detailed reference books on the subject, its purpose has been well achieved. ■ ■ ■

News to Heat Treaters

the furnace. The heat treater merely sets pointer on the control instrument for the carbon content of the steel he wishes to treat and the Carbotrol will automatically control the atmosphere generator to produce a protective atmosphere in equilibrium with the steel.

The manufacturer states that the Carbotrol also eliminates the disadvantages of operating an endothermic generator on a raw gas supply, such as manufactured gas, which varies in analysis throughout the day. The Carbotrol automatically corrects the air-gas ratio of the generator to produce a constant dew point, or carbon potential, as the raw gas supply and pressure varies.

For further information circle No. 32

(continued on page 46)

FOR SALE
MODERN CONVEYOR FURNACE BARGAINS!
All Used Less Than One Year!
BRIGHT ANNEALING: 16"w, 22'l, 7"h muffle. GF. NEW
BRAZING: 100KW, 18"w, 10'l, 10"h. Complete with dryer, generator, controls.
HARDENING: 800 lbs/hr. 24"w, 13'l, 6"h, 78KW. NEW
TEMPERING: 900 lbs/hr. 17"w, 24'l, 15"h, recirc. GF
Also Salt Baths, Atmosphere Generators, Quenches.

FOR SALE
CARBURIZING FURNACE BARGAINS!
New Ipsen Carbonitriding Furnace
Model TC 300 E. Also rebuilt T250.
L & N Homocarb, 24" dia. 36" deep.
S. C. pusher, radiant tube, 34"w, 25'l, 15"h.
S. C. Shaker Hearth, 24"w, 100"l, 7"h.
Please call collect or drop a card for our complete list of heat treating, melting and metal finishing machines.

METAL TREATING EQUIPMENT EXCHANGE
9825 GREELEY DETROIT 11, MICHIGAN
TOwnsend 8-8450—Please call "collect"

EDITORIAL

(Continued from page 1)

these essential activities are dependent upon heat treated parts or include heat treating operations.

We are at a complete loss to understand how this correct recognition of essentiality from an industry standpoint can be established without a parallel recognition of the equally essential processes and services which must be available to such industries.

Our industry feels that it is most important that the Interagency Advisory Committee have these facts brought to their attenion for further study, particularly in view of your statement that the lists are "flexible and subject to change." Some hardship has been created by the omission from this critical list of the occupation of "Heat Treater, all around," and in some instances services to essential industries have possibly suffered.

It will be appreciated if you will bring this to the attention of the proper parties and advise us of any further action or thinking on this subject.

Sincerely yours,
METAL TREATING INSTITUTE

C. E. Herington
Executive Secretary

Tempilstiks°
quick, simple, accurate way to tell temperatures

use like a crayon

It's this simple: mark the workpiece with the proper Tempilstik°. When the mark melts, the specified temperature has been reached.

to control working temperatures in:
- welding
- flame-cutting
- tempering
- forging
- casting
- molding
- drawing
- straightening
- heat-treating in general

$2 each
gives up to 2000 readings

Available in these temperatures (°F)

113	263	400	950	1500
125	275	450	1000	1550
138	288	500	1050	1600
150	300	550	1100	1650
163	313	600	1150	1700
175	325	650	1200	1750
188	338	700	1250	1800
200	350	750	1300	1850
213	363	800	1350	1900
225	375	850	1400	1950
238	388	900	1450	2000

Also available in pellet or liquid form

FREE —Tempil® "Basic Guide to Ferrous Metallurgy" — 16¼" by 21" plastic-laminated wall chart in color. Send for sample pellets, stating temperature of interest to you.

Metal & Thermit Corp. 100 E. 42nd Street, New York 17, N. Y.

For further information circle No. 33

INSTITUTE NEWS

Member Nominated for Award

Mr. Philip C. Osterman, President of American Gas Furnace Co.; Vice-President and Secretary of the American Metal Treatment Co., a member of the Institute; and a member of the American Society of Mechanical Engineers, has had a long and distinguished career as an engineer and authority in the field

PHILIP C. OSTERMAN

of gas furnace development and technology.

The Executive Committee of Plainfield Section of the American Society of Mechanical Engineers felt it a privilege to recommend Mr. Osterman to the Board of Honors to receive award of the ASME 75th Anniversary Medal, as the member who has done most for the section to further the aims and objectives of ASME.

1955 Annual Meeting

The Hotel Warwick, Philadelphia, Pennsylvania, has been chosen as the site for this year's Annual Meeting of the Metal Treating Institute. It will take place on October 14th, 15th and 16th, and while the program is not yet complete, it promises to be of interest and value to all Institute members.

The Nominating Committee consisting of J. Robert MacAllister of Syracuse Heat Treating Corp., Chairman; Fred Heinzelman, Jr. of Fred Heinzelman & Sons; Charles H. Hewitt of Dayton Forging & Heat Treating Co.; Charles I. Wesley of Wesley Steel Treating Co.; and Arlo E. Leidig of Hollywood Heat Treating Co., are hard at work selecting a slate of nominees to be presented to the membership for election of next year's officers and directors.

Another important event will be the presentation of the second *Annual Metal Treating Institute Achievement Award* to the author of the most outstanding lecture presented at the 1954 Annual Meeting or the 1955 Spring Meeting, or for any paper appearing in *Metal Treating* between the November-December 1954 issue and the September-October 1955 issue.

Nitriding Installation

Bennett Heat Treating Co., Inc., Newark, N. J., has recently announced a new nitriding installation. This equipment, licensed by Nitralloy Corp., is an addition to the many other heat treating and special services rendered by the company.

Members Merge

Allied Metal Treating Corp. of Kenosha, Wisconsin, announced the full acquisition of the facilities of Wesley Heat Treating Co. of Manitowoc; Wesley Metal Treating Co. of Racine; Spindler Metal Processing Co. of Racine; and Capitol Heat Treating Co., Inc. of Racine.

The officers of the enlarged corporation are Charles I. Wesley, President; Mrs. Ann F. Wesley, Vice-President; Harold R. Wesley, Secretary; and Joseph F. Hushek, Treasurer.

"HELLO, - ETERNAL CHAIN COMPANY? -- YOU SURE DO A LOUSY JOB OF HEAT TREATING YOUR CHAINS!"

MANUFACTURERS' LITERATURE

For your copy circle the number on the Readers' Service Card

L&N DATA SHEETS

Complete information about L&N's new "Speedomax" Type H indicators, recorders and controllers is now available in a series of five data sheets, ND46-33 (100) to (104), just published by Leeds & Northrup Company. These data sheets describe how these new instruments can be used to indicate or record temperature, or to provide Two-Position or one of three types of proportioning control.

Included in these sheets are photographs and line drawings illustrating the design features of the new line. To facilitate control selection, these sheets list various process conditions for which each type of control is usually recommended, and in addition, provide an illustrated, tabular arrangement of complete control systems.

For further information circle No. 34

INDUCTION HEATING

An 8-page bulletin describing a complete line of induction heating equipment is available from the Westinghouse Electric Corporation. The high-frequency motor-generator sets and associated apparatus discussed are specifically designed for induction heating operations such as hardening, annealing, brazing, forging, and heat treating of metals.

The motor-generator sets described have standard output frequencies of 960, 3000, and 9600 cps, with power ratings of 30 to 1500 kilowatts, and higher.

Accessories include output stations to provide operating flexibility; transformers to match generator output voltage with work-coil voltage; capacitors to correct power factor and assure maximum output; contactors to control application of generator power; and water systems for capacitors, transformers, and other equipment.

Electrical and mechanical specifications are included for each equipment, and construction features are discussed.

For further information circle No. 35

ALLOY STEELS

A new 200-page handbook entitled "Alloy Steels Pay Off" is offered by the Climax Molybdenum Company, New York, N. Y., to engineers, purchasing and managment personnel who are interested in the practical utility of alloy steels in modern equipment design.

Highlighted in this book are the economic advantages of fabricating with alloy steels for improved weight-to-strength ratios in aircraft construction, bridges, electrical equipment, machinery, trucks and buses, etc.: longer life and less maintenance; heavier payloads and lower operating costs; improved safety and overall savings in freight and shipping costs. Advantages of high impact strength and shock-load resistance are discussed, as well as savings resulting from improved resistance to corrosion and wear.

For further information circle No. 36

ELECTRONIC FLOW METERS

A 12-page bulletin issued by The Hays Corporation, Michigan City, Indiana states that now a choice of several mercury-less transmitters is offered with the Hays Electronic Flow Meters. These meters are for measurement of differential pressures; liquid level; fluid, gas, air or steam flow; and temperatures and pressures. They feature counter continuous integration, 12-inch uniformity graduated charts, and a choice of several style indicators is possible. Combination of flows or flow and level can be recorded on same chart and over pressure protection in either direction is provided.

For further information circle No. 37

TOOLROOM PLANNING

"How to Plan Your Toolroom Heat Treating Department" – a practical guide to assist those planning new, enlarged or redesigned heat treating departments is available without cost from the Furnace Division, Lindberg Engineering Company, Chicago, Ill.

The 24-page, two-color booklet describes how to select furnaces of the proper size; shows recommended layouts; gives approximate floor space requirements and lists auxiliary equipment such as tongs, straightening presses, work benches, hardness testers, etc.

For further information circle No. 38

CENTRIFUGAL WET DUST COLLECTOR

Foundrymen, heat treaters, chemical engineers, metallurgists, plant engineers, safety engineers and those faced with the problem of control of hot or moist, explosive or combustible, corrosive, abrasive or obnoxious dusts have available a new 4-page bulletin published by the Pangborn Corporation, Hagerstown, Md., describing the type "CW-1" centrifugal wet dust collector. The action of the patented vanes in dispersing the liquid to obtain greater capacity in reduced space is described.

For further information circle No. 39

ULTRASONIC CLEANING EQUIPMENT

The Acoustica Model DR-400 Ultrasonic Cleaning Equipment for production cleaning and degreasing of precision products, electroplating, soldering aluminum, degassing molten aluminum, metal cutting and many other applications in metal working machinery, welding, heat treating, and foundry shops is described in a new bulletin just published by Acoustica Associates, Inc.

Also listed in the bulletin are a number of unusual, cost-saving, ultrasonic applications for machining hard materials, emulsifying immiscible liquids, descaling metals, and cleaning and degreasing potentiometer elements and complex castings.

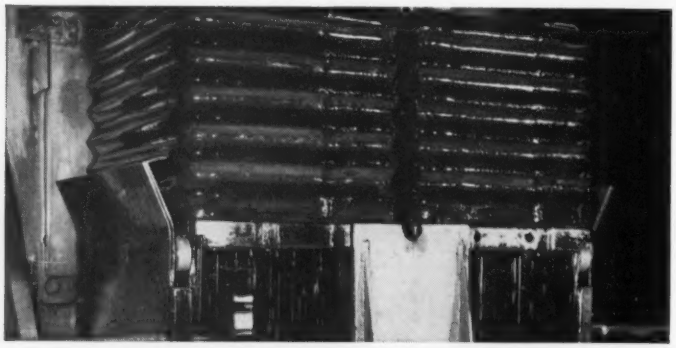
For further information circle No. 41

NEW TITANIUM ALLOY

A new bulletin describing the MST 6A1-4V titanium alloy has been prepared by Mallory-Sharon Titanium Corporation, Niles, Ohio. The bulletin lists metallurgy and chemistry of the alloy, properties, and recommended heat treatment, forging, and welding procedures.

It is stated that the new alloy overcomes the problem of elevated temperature embrittlement present with many titanium alloys, and can be used at temperatures up to 750°F. with minimum creep or change of properties. They maintain that it has excellent strength and stability at high temperatures, is relatively insensitive to notches, and can be hot worked over a wide range.

For further information circle No. 42



Sun Quenching Oil No. 11 lasts four times longer than costly compounded oil

Provides clean, bright-quenched parts at lower cost ... keeps tanks and coolers cleaner longer.

To get clean, bright-quenched parts, J. W. Rex Co., Lansdale, Pa., one of the foremost heat treaters in the country, had to drain their 1500-gallon quench tank every few weeks. High oil cost and frequent shut-downs for tank and cooler cleaning became too expensive.

A Sun representative made a thorough analysis of this problem. He then suggested a switch to Sun Quenching Oil No. 11—at a price about half that of the costly compounded oil they were using.

Now, *twelve months later*, the original charge of Sun Oil is still in the tank! Make-up is considerably lower...parts are continuing to come out clean and bright ...and...tank maintenance costs are practically nil!

To find out how a Sun Quenching Oil can help *you* heat treat metal at lower cost, phone your local Sun representative or write SUN OIL COMPANY, Philadelphia 3, Pa. Dept. MR-7.

SUNOCO®

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

Philadelphia 3, Pa.

IN CANADA: SUN OIL COMPANY, LTD., TORONTO AND MONTREAL

For further information circle No. 40

USED MACHINERY INFORMATION

Of special interest to firms who buy, sell, or appraise used equipment is a new Serial Number Reference Book for Metalworking Machinery published by Industrial Publishing Corporation of Detroit.

Serial number and age information for most machine tools, presses, forging equipment, and industrial machinery manufactured in the United States from 1920 through 1953 is compiled in this reference volume.

Presented in loose-leaf style and bound with leatherette cover the new book is said to be the most complete serial number reference book for metal-working machinery ever published.

A yearly supplement service is also available, the publishers announced, so that the Machinery Serial Number Reference Book can be kept up to date as new information is released by the manufacturers.

The book is designed and edited for quick, accurate reference work. Serial numbers are listed year-by-year starting with 1920; manufacturers are listed alphabetically; and plenty of space has been left for personal notations as information is printed on one side of the page only.

For further information circle No. 54

(Continued on page 48)

THE APPRENTICE CORNER

Editor's Note: *The following column appears regularly in METAL TREATING and is designed to aid young men who have only recently started in the heat treating industry. If you would like to see specific subjects discussed, or if you have any questions, let us know what they are.*

Stress-Relieving Steel

Steel which has been machined, cold worked, or welded is highly stressed in some areas. The stresses are complex and may be of such high level that the structures have tendencies toward severe warping and even cracking. Stress-relieving by heat treatment is a method of reducing or eliminating these stresses without resorting to annealing or normalizing. It is a process of reducing internal stresses by heating to a sub-critical temperature and holding at that temperature long enough to assure uniformity, followed by slow cooling which will prevent the re-introduction of stresses. Stress-relieving is commonly used on structures where annealing or normalizing would be prohibitive on account of size, shape, warpage, or scale.

Stress-relieving is an operation which is performed to partially remove residual stresses resulting from heavy machine work, mechanical straightening, hobbing or other cold working. The reduction of such stress is important in avoiding excessive distortion during hardening and in avoiding cracking which could result from the addition of the residual stress to the thermal stress, produced in heating to the hardening temperature.

Stress-relieving is carried out by heating the steel in a temperature range of from 1100° to 1300°F. Because of the low temperature involved, surface protection against scale or decarburization is usually not required. The temperature used is always below the transformation range of the steel. Therefore, the rate of cooling is unimportant except that it must not introduce thermal stress during cooling. Only a portion of residual stress is removed by this procedure. Up to the lower critical, the higher the stress-relieving temperature, the more completely is the stress removed. The degree of stress-relief afforded in this manner is usually sufficient to avoid the difficulties mentioned above; but if for any reason, complete relief of stress is required, a full anneal practice, including full austenitization and slow furnace cooling, should be employed.

After the steel has been stress-relieved, the dimensions should be re-measured. Dimensional changes are an indication that stress has been relieved. It may therefore be necessary to correct some dimensions before proceeding without hardening. If no dimensional changes result from stress-relieving, either the procedure was ineffective or no appreciable stresses were present. ■ ■ ■

LP GAS INSTALLATIONS and ANHYDROUS AMMONIA PLANTS

More than 80 Peacock Plants prove . . .
"There's No Substitute For Experience"
PEACOCK CORPORATION
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Westfield 2-6258

SPECIAL ALLOYS *plus* EXPERIENCED TECHNICIANS Assure WELDMENTS by STANWOOD that can "live with heat".

While we have made fabrications and weldments a few inches in diameter, the big, bulky, fussy, intricate jobs, which some shy away from, are our meat. These jobs are typical . . . correct metals used for the particular job involved . . . skillful, smooth fabricating . . . sound, gastight welds throughout. We do it every day . . . we'd like to do it for you. Send for literature.

Pressure tested Ammonia Dissociator.

Specially designed, pit type, quenching tank.

Retort for Electric Heat Treating Furnace.

Stanwood Corporation
HEAT TREATING EQUIPMENT
4825 W. CORTLAND ST. CHICAGO 39, ILLINOIS

For further information circle No. 43

LETTERS TO THE EDITOR

Dear Editor:

Just a note to let you know that we are very pleased with the treatment that you have given our story "Bright Hardening and Bright Tempering of Corrosion-Resistant and High-Temperature Alloys" by T. W. Harker in the May-June issue of METAL TREATING.

You certainly did a nice job in presenting the story and we hope that it will be of real interest to many of your readers.

Would you please send us a half dozen tearsheets of the story for distribution to our key personnel?

If you can supply us with covers to go with those tearsheets it will be appreciated, as you have used the main illustration quite effectively as your cover photo.

R. C. WAYNE,
Advertising Manager,
Industrial Division
Surface Combustion Corp.
Toledo, Ohio.

Ed.—Six copies were sent.

Dear Editor:

I should like to ask a few questions concerning the news item on page 32 of the March-April issue of METAL TREATING headed "New Furnace for Metallurgical, Inc."

The new furnace described and pictured there is a variation of our inverted pit furnace and presumably does have a considerably larger heating space. However, I would question several statements and claims.

What is meant by the statement that the Vertical 752 furnace "normalizes aluminum"? What is meant by "neutral" atmosphere, and how does it "insure bright work" except where the work is allowed to cool in the furnace? Work quenched from a non-scaling atmosphere into oil, salt, or water will not come out bright.

I do not understand the statement that "instruments control the furnace temperature within plus or minus 5° to 2200°F. because pyrometers are, at best, accurate to about ½% of the range which would be plus or minus 11°F. at this temperature.

It would be interesting to know the working diameter and height of the heating space and thereby know what size parts it will accept. Also, what weight of charge will it accept and is the furnace supplied with a recirculating atmosphere blower which is generally necessary in the heat treatment of aluminum alloys?

HORACE C. KNERR, President
Metlab Company
Philadelphia, Pennsylvania

Ed.—A copy of this letter has been sent to Mr. A. T. Ridinger, President of Metallurgical, Inc., and we hope to be able to print his answer in the next issue.

Gentlemen:

We enclose a bank draft for six dollars to cover one year's subscription to METAL TREATING.

We should like at this stage to

A heat treating furnace that maintains a controlled atmosphere during treating. Bottom-charging—automatic—self-quenching. Readily converted from one heat-treating process to any other. If you treat gears, castings, small parts, you should have this new bulletin. Ask for Bulletin No. 652.

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The DENVER FIRE CLAY Company
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INDIANAPOLIS
Loy Instrument Co.
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KANSAS CITY, MO.
Central States Equip. Co.
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LOS ANGELES
Automatic Inst. Service Co.
7807 So. Compton Ave.

MILWAUKEE
Wis. Inst. & Control Co.
1404 W. Fond du Lac Ave.

MINNEAPOLIS
American Steel Prod. Co.
2828 Lyndale Ave. South

OAKLAND
Russo Foundry Equip. Co.
3882 Fairway Ave.

CHICAGO
Abbot Corporation
808 West Erie St.

OMAHA
Fuchs Mach. & Supply Co.
2401 No. 11th St.

PITTSBURGH
John E. Finger Co.
1123 La Clair Ave.

ROCHESTER, N. Y.
Marin-Mercier Co.
36 Winthrop St.

ST. LOUIS
Shea-Brownell Co.
3903 Olive Street

For further information circle No. 44

record our appreciation of the excellent material which has always been published in METAL TREATING, and to confirm that we are very happy to continue taking it at the small subscription you have fixed.

ERIC PATON LIMITED
Auckland, C. I.
New Zealand

Ed.—Thanks, and the subscription was noted.

Dear Sir:

We noticed in the article on "Two West Coast Shows" in the May-June issue of METAL TREATING, a reference was made to a Sanford Process to hard-coat aluminum components. Mention is made of the Sheridan Products Company of Inglewood, California, who exhibited aluminum parts which had been hard-coated by this process.

We are interested in obtaining more information concerning the Sanford Process. Would you please send us the address of the Sanford Company?

P. B. JENSON, Works Metallurgist,
Motor Truck Division
International Harvester Co.,
Chicago, Ill.

Ed.—The address was sent along with a copy of the Nov.-Dec. 1954 issue which contained an article by J. B. Franklin of the Company, entitled "The Sanford Process."

Gentlemen:

We read with interest the article on Spring Type Holders used in Heat Treating of Drills in your "Heat Treating Hints" column of the March-April issue.

We are asking if you can tell us where we may obtain more information regarding these springs?

C. C. SPITZFADEN
Purchasing Agent,
The Tool Steel Gear and Pinion Co.,
Cincinnati, Ohio

Ed.—After correspondence with the editor of METAL TREATMENT AND DROP FORGING *in England and with various companies, the necessary information was sent on.*

Gentlemen:

Mr. A. S. Eves article, "Keep That Shape" in *The Apprentice Corner* department of your May-June issue of METAL TREATING is good, sound, fundamental advice that so many engineers and tool and die makers too frequently ignore.

Mr. Eves, like the writer, in calling on the trade, undoubtedly gets his share of abuse from his customers when troubles occur. I believe that I am safe in saying that we are usually in a position to dump over 90% back into their own laps, and do it convincingly.

I would be very happy to be able to get several copies of this article from you if possible, to distribute to a few shops where I am sure it might prove effective.

WALTER C. SCHALM
Harbor Metal Treating Co.,
Benton Harbor, Mich.

Ed.—Six copies were sent.

Dear Editor:

Would it be possible for you to send me a copy of the January-February issue of METAL TREATING?

I saw a copy of the magazine at

(Continued on page 48)

heat and corrosion resistant

CASTINGS & FABRICATIONS

CARBO-NITRIDING TRAY

This General Alloys Company tray, available from stock, is designed for use in the Ipsen T-400 carbo-nitriding furnace. It is a combination of cast and rolled alloy, utilizing the inherent advantages of each, resulting in a lightweight, flexible tray. It has a rugged, semi-tubular outside member to withstand pushing stress and prevent structural deformation. The load is carried in a wire mesh liner and is supported by high-strength cast clips that automatically adjust to the hearth surface and provide a flat, wear-resistant bearing surface. This prevents high localized loads and "digging in" on the hearth surface. This general design also has many other applications.

GENERAL ALLOYS COMPANY

403 WEST FIRST STREET • BOSTON 27, MASSACHUSETTS

For further information circle No. 45

NEWS TO HEAT TREATERS

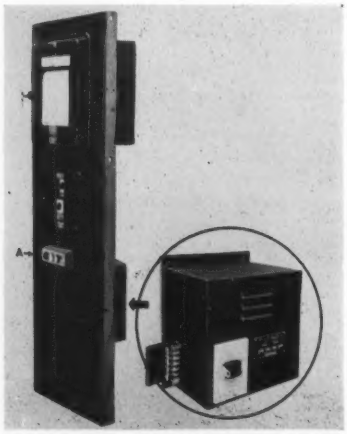
(Continued from page 39)

Thermocouple Monitor

The Restorer, for correcting inaccurate temperature reading and control caused by thermocouple circuit failure during heat treating and melting operations, is a new product of The Peerless Electric Company, Electronics Division, Warren, Ohio.

The Restorer's special electrical impulse is said to renew proper conductivity in thermocouple circuits by breaking down excessive resistance caused by corroded, oil-soaked or loose circuit connections. This permits pyrometers and controls to obtain proper thermoelectric voltages from the couple and assures accurate temperature reading and control during heats.

The Restorer operates manually or automatically. It mounts on existing pyrometer panels or on its own central control panel when many thermocouples are monitored in an instrument room. One Restorer unit checks as many thermocouples as is desirable and practical.



The Protection Tube Leak-Checker warns against incorrect temperature reading or control caused by seepage of molten material into thermocouple protection tubes immersed in salt bath furnaces, open hearth baths, and other melting furnaces. The Leak-Checker operates with the Restorer or independent of it.

For further information circle No. 47

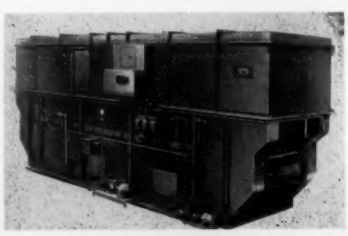
Ultrasonic Degreasers

New low frequency flat-type transducers developed for Circosonic ultrasonic metal degreasing equipment improve the efficiency of ultrasonic cleaning methods and greatly extend the size of workpieces that can be handled, according to a statement announced by the Circo Equipment Company, Clark (Rahway) N. J.

It is claimed that low ultrasonic frequencies have greater penetrating ability and therefore greater cleaning efficiency than the higher frequencies previously employed. The effect is analagous to low frequency radio signals which can be received in almost any location, as compared with high frequency television waves which are subject to shadow effect and line-of-sight reception. In the new equipment, low frequency ultrasonic waves, generated by barium titanate transducers of new design, are said to curve around corners and sharp angles, penetrate more easily into recesses and capillaries to remove all dirt, oil, grease, chips and lapping compound from the article to be cleaned.

The flat shape of the transducers permits them to be teamed to any length or width for cleaning large shapes such as transmission pumps and gears. Because sound energy is beamed over a wider area, small parts like bearings and electronic components can now be cleaned ultrasonically without requiring critical positioning.

As the transducers expand and contract under electrical excitation, the resulting ultrasonic energy causes severe cavitation in the surrounding cleaning solution, usually Trichlorethylene or Perchlorethylene. It is this cavitation that actually cleans the metal parts, subjecting them to an extremely rapid scrubbing action which accomplishes in seconds what even hours of hand cleaning could not do. Redesign of the barium titanate crystal transducers permits them to be driven at higher watt densities, so that the sound waves need no longer be focused to produce adequate intensity of cavitation.

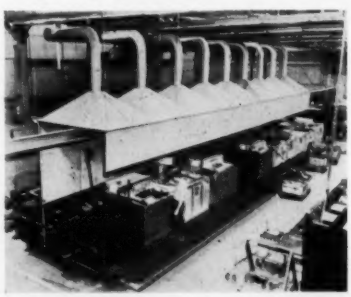


The new transducers are now available as standard equipment in Circosonic 500 watt, 2 kw, 10 kw, and 25 kw ultrasonic units, each comprising an ultrasonic generator and an ultrasonic chamber. Units are available separately or integrated with Circo conveyorized or hand operated vapor degreasers. Ultrasonic chambers may also be integrated into existing degreasing machines with liquid immersion stages.

For further information circle No. 48

Salt Bath Furnaces

Saco Lowell Shops, Saco, Maine, recently completed the installation of what is believed to be the world's longest line of batch-type electric salt bath furnaces. Used for heat treating components for machine guns, the equipment, produced by Ajax Electric Company, Philadelphia, is used for large volume neutral hardening, martempering and tempering operations.



Versatility is said to be the keynote of this arrangement as the furnaces are arranged so that work can be easily and quickly transferred from a neutral hardening salt bath into an adjacent isothermal quenching (martempering) salt bath unit or an adjacent oil quenching tank. The "line-up" from left to right is: oil quench tank—neutral hardening

(Continued on page 48)

METAL TREATING

EQUIPMENT and MATERIALS DIRECTORY

AGITATORS

J. P. DEVINE MANUFACTURING CO.
49th Street and A. V. R. R.
Pittsburgh 1, Pennsylvania

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HEAT TREATING FIXTURES

AMERICAN BRAKE SHOE CO.
ELECTRO-ALLOY DIVISION
Elyria, Ohio

GENERAL ALLOYS COMPANY
367-405 West First Street
Boston 27, Massachusetts

INTERNATIONAL NICKEL CO., INC.
67 Wall Street
New York 5, New York

MISCO FABRICATORS, INC.
1999 Guoin Street
Detroit 7, Michigan

THE PRESSED STEEL COMPANY
Wilkes-Barre, Pennsylvania

ROLLED ALLOYS, INC.
4815 Bellevue Avenue
Detroit 7, Michigan

ROLOCK INC.
1232 Kings Highway
Fairfield, Connecticut

STANWOOD CORP.
4825 W. Cortland St.
Chicago 39, Ill.

WIRETEX MFG. CO., INC.
16 Mason Street
Bridgeport 5, Conn.

★ ★ ★

CLEANING EQUIPMENT

PANGBORN CORPORATION
Hagerstown, Maryland

★ ★ ★

FABRICATION (Heat & Corrosion Resistant)

WIRETEX MFG. CO., INC.
16 Mason Street
Bridgeport 5, Conn.

★ ★ ★

FURNACES

AMERICAN GAS FURNACE CO.
808 Lafayette Street
Elizabeth, New Jersey

DENVER FIRE CLAY COMPANY
2301 Blake Street
Denver, Colorado

HARPER ELEC. FURNACE CORP.
51 River St.
Buffalo 2, New York

HEVI DUTY ELECTRIC COMPANY
Milwaukee 1, Wisconsin

INDUSTRIAL HEATING EQUIPMENT CO.
3570 Fremont Place
Detroit 7, Michigan

LINDBERG ENGINEERING CO.
2446 W. Hubbard Street
Chicago 12, Illinois

★ ★ ★

FURNACES (Salt Bath)

AJAX ELECTRIC CO.
940 Frankford Avenue
Philadelphia 23, Pa.

THE A. F. HOLDEN CO.
11300 Schaefer Highway
Detroit 27, Mich.

★ ★ ★

GASES

ARMOUR AND COMPANY
AMMONIA DIVISION
1355 W. 31st Street
Chicago, Illinois

★ ★ ★

GAS GENERATORS

LINDBERG ENGINEERING CO.
2466 W. Hubbard Street
Chicago 12, Illinois

★ ★ ★

HEATING ELEMENTS (Non-Metallic)

NORTON COMPANY
Worcester 6, Massachusetts

★ ★ ★

IMPREGNATION EQUIPMENT

J. P. DEVINE MANUFACTURING CO.
49th Street and A. V. R. R.
Pittsburgh 1, Pennsylvania

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METAL FINISHING

ARTHUR TICKLE ENGINEERING WORKS, INC.
23 Delevan Street
Brooklyn, N. Y.

QUENCHING OILS

E. F. HOUGHTON & CO.
303 W. Lehigh Avenue
Philadelphia 33, Pennsylvania

PARK CHEMICAL COMPANY
8076 Military Avenue
Detroit 4, Michigan

SHELL OIL COMPANY
50 West 50th St.
New York 20, N. Y.

SUN OIL COMPANY
Industrial Products Department
Philadelphia 3, Pa.

★ ★ ★

REFRACTORIES

DENVER FIRE CLAY COMPANY
2301 Blake Street
Denver, Colorado

NORTON COMPANY
Worcester 6, Mass.

★ ★ ★

SALTS

AMERICAN CYANAMID COMPANY
METAL CHEMICALS SECTION
30 Rockefeller Plaza
New York 20, New York

CROWN CHEMICAL CORPORATION
Branford, Conn.

ECCO CHEMICAL CORPORATION
19th Street & Park Avenue
Weehawken, New Jersey

THE A. F. HOLDEN CO.
11300 Schaefer Highway
Detroit 27, Mich.

E. F. HOUGHTON & CO.
303 W. Lehigh Avenue
Philadelphia 33, Pennsylvania

PARK CHEMICAL COMPANY
8076 Military Avenue
Detroit 4, Michigan

★ ★ ★

STRAIGHTENING EQUIPMENT

GENERAL MANUFACTURING COMPANY
6437 Farnsworth
Detroit 11, Michigan

★ ★ ★

TEMPERATURE CONTROLS

METAL & THERMIT CORP.
100 East 42nd Street
New York 17, New York

★ ★ ★

TOOL STEELS

BETHLEHEM STEEL COMPANY
Bethlehem, Pennsylvania

CRUCIBLE STEEL COMPANY OF AMERICA
Pittsburgh, Pa.

NEWS TO HEAT TREATERS

(Continued from page 46)

salt bath—martempering salt bath—neutral—oil quench—neutral—tempering salt bath—temper—temper—temper—neutral—oil quench. Tempering furnaces are grouped together since tempering operations are preceded by an air cooling period, and transfer time from the quench to the tempering operation is not critical.

For further information circle No. 49

Endothermic Atmosphere Generator

A new streamlined endothermic atmosphere generator, completely wired, piped, and assembled in a package unit is now offered by Lind-

berg Engineering Company, Chicago, Illinois. The HYEN Hydryzing Generator is a fully automatic process for producing low cost protective atmosphere for bright hardening, bright annealing, or bright brazing of steel totally free from decarburization or carburization. Available in 500, 750, and 1500 c.f.h. sizes, the unit is said to provide production economies and give better, more precise operation with ease of maintenance.

The Lindberg Endothermic Gas Cracking Generator is said to produce a protective atmosphere by cracking gas (natural, propane, butane, or manufactured) with air over a heated catalyst. The air and gas are metered, automatically proportioned and mixed. The hydrocarbon of the fuel gas is cracked into its basic constituents and combines with the oxygen of the air at the elevated temperature to form a gas which is basically 40% hydrogen, 20% carbon monoxide, 1.0% hydrocarbon and nitrogen as the balance.

The completely reacted, dry, hot atmosphere can be piped directly to the heat treating furnace or it can be cooled in the gas cooler for metering and distribution purposes where more than one heat treating furnace is to be supplied with the generator gas.

For further information circle No. 50

MANUFACTURERS' LITERATURE

(Continued from page 42)

HOMOCARB METHOD DESCRIBED

A new 20-page catalog, "The Homocarb Method with Microcarb Atmosphere Control for Heat Treatment of Steel", has just been issued by the Leeds and Northrup Co., Philadelphia, Pa. It tells how Homocarb furnaces with Microcarb control are being used for case carburizing, carbon restoration, homogeneous carburizing and hardening of steel products on a reproducible, mass-production basis.

Installation photos and case histories tell why this method is said to help produce better products at less cost in hundreds of metal working plants.

Included too, are complete description and specifications for Homocarb furnaces. Microcarb atmosphere control and Micromax temperature control equipment.

For further information circle No. 51

LETTERS TO THE EDITOR

(Continued from page 45)

the Cockshutt Farm Equipment Co. where I am employed and I was particularly interested in the article regarding proper die design.

I am a tool and die maker, but am often on die trouble-shooting and methods work.

DONALD W. GRAND
Brantford, Ontario

Ed.—Reprints of Strasser's article on "How to Avoid Heat Treating Difficulties Through Correct Design of Press Tools" and of Sherry's article on "Application of Nitriding to Hot Forging Dies" were sent.

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right in tune

...and REX is the standard by which all other high speed steels are compared

A tuning fork sounds the *standard pitch* to which musical instruments are compared. There's a recognized standard for high speed steels, too — Crucible REX®.

But don't take our word for it. Try REX in your own shop. Compare its structure, finish, hardenability, carbide distribution and general uniformity. Measure the *extra performance* you get. You'll see for yourself why no other tool steel outperforms REX . . . why it's the *standard for comparison* wherever high speed steels are used.

Next time you buy tool steels, be sure of top performance — specify REX. Remember, it's made only by Crucible — and is available from local warehouse stocks, or by prompt mill delivery. *Crucible Steel Company of America, Henry W. Oliver Building, Pittsburgh 22, Pa.*

CRUCIBLE first name in special purpose steels

Crucible Steel Company of America

For further information circle No. 52

For warp-free heat treating...

Craftsman Rotary Power Lawnmowers are sold exclusively by Sears, Roebuck & Co., and are made by Newark Stove Co., Newark, Ohio, a Sears subsidiary. Uniform heating in AEROHEAT 1200 and 300 baths prevents warping of carefully balanced blades during heat treatment.

Sears, Roebuck & Co. austempers rotary lawnmower blades to 42-50 Rockwell C in AEROHEAT 1200 and 300 *heat-treating compounds*

Sears wanted minimum distortion when heat treating these blades, so they chose the salt bath technique. For long bath life and simple trouble-free operation as well, they chose AEROHEAT 1200 and 300 heat-treating compounds.

Blades of SAE 1065 steel are austempered warp-free to 42 to 50 Rockwell C from AEROHEAT 1200 at 1550°F, quenching in AEROHEAT 300 at 650°F. Giving a neutral bath, AEROHEAT 1200 contains a built-in rectifier to prevent carburizing or decarburizing the steel. The AEROHEAT 300 bath is a stabilized nitrate-nitrite mixture of high chemical purity, ideal for low-temperature operation.

Put low-cost, high-control salt bath treating to work for you now. For full details, or prompt service from our staff technical experts, check the coupon below.

Cyanamid's heat treating compounds include:

AEROCARB® Carburizing Compound
AEROCASE® Case Hardening Compounds
AEROHEAT® Heat Treating Compounds

Other products for metal processing include:

AEROMET® Metallurgical Additive
Metallic Stearates
Surface Active Agents
Acids and other Heavy Chemicals

*Trade-mark

MT-3

AMERICAN Cyanamid COMPANY
METAL CHEMICALS SECTION
30 Rockefeller Plaza, New York 20, N. Y.

☐ Send data sheets on AEROHEAT 1200 and 300
☐ Have technical representative call

Name_____ Position_____
Company_____
Address_____
City_____ State_____

In Canada: North American Cyanamid Limited, Toronto and Montreal

For further information circle No. 53